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This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 22/- net.

THE THOUGHTS OF THE ANCIENT GREEK PHILOSOPHERS CONCERNING THE NATURE OF LIGHT AND A GLANCE AT THE PRESENT-DAY LIGHT PROBLEMS.

By DR. W. TOMBROCK.

Pythagoras, Plato, Aristotle.

Roughly speaking we know of two types of theories of light, that of Newton: light and sight are caused by emitted particles—emission; and that of Huyghens: light is produced by waves in a medium—undulation. It is less generally known that these two theories have already had their forerunners in antiquity during the Greek culture-period. For the sake of clearness we will choose three from these, each connected with the name of a well-known classical figure; whoever wishes to have a more complete review may be referred to our source, Preston: "Theory of Light."

According to Pythagoras visibility is caused by particles, which, being continuously projected from the surface of the visible objects, penetrate into the pupil of the eye. He had thus an emission theory in its most rudimentary form.

Plato considered three things to be necessary for sight: a stream of light or divine fire coming *from* the eye, other light which unites with this stream and finally an emanation proceeding from the visible objects which completes the light effect with the first two. He thought of light or the stream of vision as a single body which became suitable for the purpose of sight by the union with other light; if this body touched another stream of light coming from the visible objects then the mutual motions spread themselves, as it were, over one single body and thereby reached our soul, wherein they then evoked the sensation of vision.

It is characteristic that Plato appears to attach importance to something which *proceeds from* the eye, rather than to that which streams towards it and which was emitted by the object seen. But nevertheless, in agreement with Pythagoras, he finds this latter emission also necessary and he imagines that without the action of other light — from an obliging light-source — nothing can be seen. Let us here give Plato's own words as it can be found translated in Preston: "and the pure fire which is within us and akin to this, they (the gods) made to flow through the eyes in a single, entire and smooth substance, at the same time compressing the centre of the eye so as to retain all the denser element, and only to

allow this to be sifted through pure. When, therefore, the light of the day surrounds the stream of vision, then like falls upon like, and there is a union, and only one body is formed by natural affinity according to the direction of the eyes, wherever the light that falls from within meets that which comes from an external object. And, everything being affected by likeness, whatever touches and is touched by this stream of vision, their motions are diffused over the whole body, and reach the soul, producing that perception which we call sight."

In the night, according to Plato, the stream of vision is broken. The fire is put out since a dissimilar element appears, "the eye no longer sees, and we go to sleep; for when the eyelids are closed, which the gods invented as the preservation of the sight, they keep in the eternal fire."

To our modern understanding this theory is difficult to conceive; perhaps Plato felt that he could explain vision with the aid of emitted particles, which come from the eye, only with difficulty and so the streams which come from the eye becomes one body? . . does he in spite of emission still wish to have one continuous medium for light? . . .

Setting aside this incomprehensibility, we can then assume with Plato a threefold emission : that from the source of light, that from the object seen and that from the eye.

Aristotle thought entirely differently about the phenomena of light. He disputes all emission. Light is not a material emission of any sort but only a quality or action (ενεργια) of the transparent medium (*διαφανες*). *Aristotle here is a clear ,though* superficial, forerunner of Huyghens, with his undulating ether. We will allow Aristotle himself to make this somewhat more *clear* (Preston).

" Light is then the action (ενεργια) of this pellucid *qua pellucid;* and whenever this pellucidity is present only potentially, then darkness also is present... Thus we have shown light to be neither fire, nor body generally, nor effluvium nor emanation from any body (since in this case it would be a body of a kind), but only the presence of fire, or something like it, in that which is pellucid : two bodies being unable to exist at one and the same time within the same space (!) Darkness in fact is really the removal of such a positive quality from what is pellucid, so that light must necessarily be its presence." Aristotle distinguishes sharply in this place between " energy " (ενεργια) and what we now call ether (διαφανες). In my opinion it is clear that Aristotle looks up the ether (what is pellucid *—διαφανες) as a substance and light is accidental, an activation of this substance. But the most noticeable thing is that from the very beginning it is here thought that the* two forms of representation, emission and undulation exclude one another. This idea *of the mutual incompatibility remains later* also in the foreground — *plenum versus vacuum*—and it is not impossible that it is just this idea which is the actual source of much that is strange and incomprehensible to be found in modern theories of light. One might say that the problem of the luminiferous ether has been wrongly put from the beginning. And yet, where one practically spontaneously arrived at the two forms of representation, one might have had to consider the possibility of the existence of the two representations together.

And now a single glance at the problem of light as it appears in our day.

Millikan, in " Scientia " 1927, XLI), " Conceptions in physics changed in our generation "—writes : " Now up to 1900 all the phenomena of ether waves had seemed to fit accurately and beautifully into this sort of wave-theory."

Then we were clear, the whole of physics with the exception of a few details was illuminated, until... " a group of new phenomena were discovered which suggested rather the emission theory " — of one of these phenomena Millikan says *(loc. cit.)* : " It obviously fits better some sort of corpuscular theory than a wave-theory." This was indeed so strong that... " Einstein has *suggested abandoning* the wave theory of light altogether and returning to a modified corpuscular theory "—Millikan (*loc. cit.*)

Yet one could not let the wave-theory—*undulation—go :* " We have discovered a whole group of new phenomena to which the old laws do not apply; yet we must retain the old laws for the interpretation of the old phenomena " *(loc. cit.)*

And that which is missing *now* is formulated by Millikan as follows :

" We have at present no one consistent scheme of interpretation of physical phenomena... We use the wave-theory, for example, where it works; we use the quantum theory, where it works; and we try to bridge the gap between the two apparently contradictory theories, in a purely formal fashion, by what we call the correspondence principle " *(loc. cit.)*.

In a word, emission and undulation at the present day stand unshaken side by side and opposite to one another as in the days of Aristotle.

If we are a little predisposed to do so, we could say that there exists the request, as much in the ancient days (of the Greek culture) as in modern times, for a fundamental material hypothesis, which can unite the two, at first sight, mutually exclusive forms in which light appears, the emission—radiation from a light source—and the undulation—propagation through a medium.

That such an hypothesis, which superficially and roughly speaking is satisfactory, can exist we have already pointed out in our conception of the structure of ether, protons and electrons (*The Chemical News*, 1928, cxxxvi, 193; see also *ibidem*, 289).

The emission is here the (primary) sending out of the electrons by the atom, the undulation the (secondary) disturbance set up in the ether by the rotating electrons.

Shall we venture now on a clear example?

As we premised (*The Chemical News*, 1928, cxxxvi, 289), a part of the ether-particles from the surroundings of the earth must be found again in the proton-mills (atoms) of which the earth consists and thereby the phenomenon of gravitation would be produced.

Let us now consider a bundle of directed *radio* waves (Marconi) which circulate around our globe.

Since no essential difference exists between this radiation and light radiation, we consider this bundle as consisting of an incessant, more or less continuous (less or more interrupted) stream of rotating electrons. These thus traverse over a definite path the ether-particles which are there on their way to the proton-mills of the earth and bring about disturbances herein which will give the—now understandable—effect.

That in this interaction the ether-particles, which strike the earth under the suctional action of the proton-mills, will also have something to do with the bending of the radio bundle round the earth has already been mentioned by us. (*loc cit.*)

May, 1928.

Bergen op Zoom,
Holland.

FURTHER USES OF ACTIVE CARBON AND SILICA GEL.

By MAURICE SCHOFIELD, M.A., B.Sc., A.I.C.

In a previous article reference has been made to the new adsorbents, active carbon and silica gel, and the use of the former for decolorisation of oils, syrups, etc., has been described:

There is a second series of uses of these new carbons, however, in which they are employed in the selective adsorption of vapours from gases, and it is in this field of operations that a rival of an inorganic nature has been introduced, *viz.*, colloidal silica.

The mode of utilising either kind of adsorbent in practice depends upon the question as to which of three types of purification the particular operation belongs. There is the first case in which a gas is to be freed from water-vapour or other impurity of no value, and in which the adsorbed phase has to be ejected from the adsorbent with little or no damage to the latter. The drying of blast-furnace air by silica-gel, and the purification of carbon dioxide from brewery-vats by active carbon are examples.

The second type is that in which the adsorbed constituent is required, whilst the gas passing on is useless and is blown to the atmosphere. To this type of adsorption belong the many processes of solvent recovery which are of such economic importance at the present day.

Lastly we have the case in which both the purified gas and the adsorbed phase are required, an example of this being the recovery of benzol from coal-gas and from coke-gas oven gas.

The use of any proprietary brand of active carbon is not so much determined by its power of adsorption as by the question of ease of regeneration and by the "working life" of the material. Most brands certainly possess a high capacity for adsorption and selectivity for organic vapours, and they are undoubtedly superior to the oil-washing process for benzol recovery. It is claimed that a carbon can adsorb 15 per cent. of its own weight of benzol before passing one gram benzol per cubic metre in the effluent gases, whereas the wash-oil is unable to approach to anywhere near this efficiency.

Important work on the relative merits of active carbon and silica gel for benzol adsorption has been published by the Joint Benzole Research Committee. In this work it was found that the efficiencies of the two materials are about equal, for although the carbons show a higher adsorption capacity than silica when calculated on weight, yet the question of "adsorbent space" comes into play, and the capacities calculated on this factor are about the same. A definite breaking-point is evident at which the adsorbent vapours commence to pass through, and a corresponding fall in temperature due to the change in heat of adsorption occurs at this point. Cocoanut charcoal furnishes

an example of a highly efficient material for adsorption work, the use of which, however, is vitiated by the difficulty of removal of benzol by the steaming-out process. This type of char also furnishes an example of an adsorbent which is "poisoned" by the presence of high-boiling constituents in the gas.

The application of active carbons to industrial processes is further illustrated by the petroleum industries, and by the rubber, celluloid, and cellulose lacquer industries in America and on the Continent. In the former industry the natural gas, consisting of methane plus small amounts of the less easily liquefiable gases, is stripped of the higher members or homologues by passing it through the carbon until a point well below the saturation-point is reached. Cooling-coils are necessary in order to counteract the heat of adsorption, and the current of gas is directed to the second adsorber-unit when desired. Heating by direct and indirect steam is employed to rid the carbon of the petrol, and about 15 per cent. by weight of the carbon used is obtained. Similarly in the petroleum refining industry activated carbon is used to prevent the escape of the more volatile components from the stills.

In the solvent recovery processes the procedure is similar, with the exception that the gas phase passing on (air) is not required. Steaming and steam-heating is employed for revivifying the carbon and obtaining the valuable solvents.

Colloidal silica or silica-gel may be employed for all the above industries, and also with great efficiency for drying air or regulating the moisture-content of air for blast-furnace work. This adsorbent is a hard granular material, with a capillary structure so well developed, that Keetschau estimates the adsorbent surface as being of the order of two and a half million sq. cm. per gram. The artificial preparation of the material is the usual one of decomposing a silicate with an acid, and in preparing gels of high activity it is essential that the product should be well washed in order to free the capillary tubes from any other products of the reaction. The subsequent degree of dehydration depends upon the process for which the gel is to be used.

The highly hygroscopic nature and ease of regeneration of this material have proved of great value for drying air-blast. The gel in granular form is placed on trays in large steel boxes, the latter being connected with the atmosphere or with the activating gases when required. The entering air is filtered from dust and the dried air may be diluted with atmospheric air, when a low but constant moisture-content is required. The heat for activation is obtained by burning blast-furnace gas, diluting with cold air to bring the gases down to 350°, and passing the resulting mixture through the unit to be activated.

Other uses of the colloid are the adsorption of sulphur dioxide and oxides of nitrogen, the drying of sulphur dioxide, and general dessication work, whilst the material can also be employed as a decoloriser and desulphuriser of oils. Future developments in the use of active carbons and silica gel are likely to be of importance, for the materials may prove of value either as catalysts, or as carriers for catalytic agents. A type of activated bone-char ("Harrison's Charcoal) is used for the commercial production of phosgene at the present day, and it has already been shown that silica-gel, being chemically and physically inert, is suitable for use as a carrier in catalytic processes. The precise nature and results of activating processes for any given material are not yet fully understood, and work in this direction should be of great value in the future of these industries.

THE COPPER NUMBER FOR GLUCOSE.

By Chester A. Amick.
Cornell University.

Introduction.

The copper number may be defined as the number of milligrams of copper precipitated as cuprous oxide from an alkaline solution of a copper salt by a unit quantity of any organic material. The determination of the copper number is a test made frequently by the carbohydrate chemist, wherein the carbohydrate is treated with alkaline copper oxide, held up usually by sodium potassium tartrate, although carbonates are used sometimes. The cuprous oxide which is precipitated by the reducing action of the carbohydrate is determined by weighing as such, oxidising to cupric oxide and weighing, or reducing to metallic copper and weighing. A shorter method is to oxidise the cuprous oxide in acidified iron alum solution and then titrate the ferrous salt with standard $KMnO_4$.

During the past twenty years, this method has been used by cellulose chemists in analysing certain degradation products of cellulose, particularly "so-called exycellulose." The results which have been obtained have not been concordant and have led to considerable confusion concerning this so-called oxycellulose.

It was the original purpose of this investigation to determine the sources of error in the analytical procedure as applied to cellulose degradation products. The preliminary experiments, however, brought out three sources of error which indicated that cellulose could not be used in such an analytical study.

1. The cellulose adsorbs the alkali tartrate solution and the adsorbed material cannot be washed out entirely.

2. The acidified iron alum used to oxidise the cuprous oxide precipitated by the reducing action of the carbohydrate liberates the adsorbed tartrate, thus causing it to be present in the iron solution which is to be titrated with standard permanganate.

3. The presence of the iron salts accelerates the reduction of permanganate by the tartrates in acid solution, thereby causing unreliable results.

Because of these errors, it seemed logical to study a simpler carbohydrate such as glucose which is soluble in water. There are also four additional advantages in using glucose.

1. It has a known molecular weight.

2. Its molecular structure is well-known, which should aid in establishing the course of the oxidation of the molecule.

3. This method has been used for its quantitative estimation for the past eighty years, and the analytical data gathered by numerous investigators should be of value in such a study.

4. Any conclusions based upon the study of glucose should be applicable, to some extent, to cellulose. Haworth and Hirst, Hibbert, Karrer, Irvine, and Gray show a definite relation between glucose and cellulose, as they use 2,3,6-tri-methyl glucose as a unit in building up their cellulose molecule.

The results which one obtains with glucose are also very discordant. The thirty-odd methods which are listed in the literature give values that vary as much as 1500 per cent. in the amount of copper precipitated as cuprous oxide by 10 milligrams of glucose. To get concordant results by any method, it is necessary to use a flask or beaker having a definite surface area; the height of the solution must be constant; the beaker must be placed at such a distance from the flame of the proper size as to bring the contents to boiling in a stated number of minutes, and this boiling must be continued for exactly the same number of minutes that the investigators used in preparing the empirical tables which accompany the method. Finally the solution must be filtered through an asbestos mat of practically non-varying thickness. Hot alkali dissolves this mat and a correction is necessary. Even with these precautions, the method recommended by the Association of Agricultural Chemists gives variations of two per cent. from time to time, due to variations in the atmospheric pressure and subsequent changes in the boiling points.

The copper number for glucose is much larger than the copper number for the same amount of cellulose. Schwalbe who was the first to employ copper numbers in studying so-called oxycellulose used as his unit 100 grams of over-bleached cotton. A high copper number for such a sample would be, say 19300.

The copper number for a 10 mg. unit of glucose usually varies from 17 to 21. This would give a value for 100 grams of glucose of 170,000 to 210,000 as compared to the 19300 for cellulose. It is evident that 100 grams of glucose is too large for an experimental sample and a smaller unit, 10 mg., is used in al lexperiments in this paper unless otherwise stated.

Conclusions.

In this paper, it has been shown that :

1. The use of alkaline copper solutions for the estimation of glucose is valueless because :

   a. The amount of the oxidation is dependent on the alkalinity of the solution.

   b. The method may be made to give any concordant results which one desires, using from one to five atoms of oxygen for each molecule of glucose.

2. It has been shown that solutions made alkaline by carbonates give higher copper numbers than those using free alkali. This result may be due to the buffer action of the carbonates, and an alkalinity too low to permit the formation of lactic acid.

3. The reducing action of the glucose molecule is *not* due to carboxyl formation from the carbonyl group as is commonly supposed; furthermore, the oxidation of the carbonyl to the carboxyl stabilises the molecule and further oxidation does not occur. This precludes the formation of gluconic or saccharic acid as intermediate steps in the oxidation process.

4. The results agree with the theories proposed by Nef and his school for the formation by reducing sugars of enediols and subsequent fision, the nature of the enediol formation and splitting being dependent upon the alkalinity of the solution, and occurring before any oxidation of the glucose molecule.

5. The volumetric method of Bertrand is inaccurate for two reasons :

a. The asbestos mat or filter paper adsorbs some of the Fehling solution which cannot be removed by subsequent washing but which is removed by the acidified iron alum solution.

b. The ferric salts catalyse the oxidation of the adsorbed tartrates by the permanganate.

6. Iron salts can be employed under certain conditions, by using sodium fluoride to remove the excess ferric ions. This forms a complex of the formula Na_3FeF_6, which is unstable in solutions of 2.5 per cent. acidity or higher. Iron salts may also be used with sodium pyro-phosphate if the acidity is kept below 0.1 per cent.

7. A new volumetric method for the estimation of glucose employing alkaline copper oxide is given by which it is possible to eliminate filtration. In this method, phospho-molybdic reagent is used to oxidise the cuprous oxide and the blue molybdenum colour is titrated to a colourless end-point with permanganate, in the cold.

8. The alkaline copper oxide is a stronger oxidising agent than the Fehling solution.

9. No experiments have been made to ascertain the effect of the presence of so-called non-reducing sugars on the determination of glucose under the new conditions.

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GENERAL NOTES.

EXTENDED WHEAT AREA IN CANADA.

In the province of Saskatchewan last fall one million acres more land were prepared for wheat than in the previous year, and reports from the West indicate that the prairie provinces as a whole have a larger area seeded to wheat this spring than has been the case since 1921, says the Royal Bank of Canada. In their first general crop report for the year, the Manitoba Free Press states that 90 per cent. of the present wheat crop throughout the west was planted before May 18 as compared with the same percentage at the end of May in 1927. The weather was particularly favourable in Manitoba and the 90 per cent. level was attained in that province by May 10. In general, then, the wheat seeding for this year was ten days to two weeks ahead of last year; by the end of May it had all been planted and in most sections was well up and the seeding of coarse grains was under way.

$3,000,000 LOAN FOR PURIFICATION OF RUHR WATERWAYS.

Cabled advices from New York state that the Ruhr Association (Ruhrverband), an association comprising numerous German municipalities and industries, has secured a loan of $3,000,000 in the American market for the improvement of its sixty water purification plants and the recently constructed hydraulic station on the Ruhr river. The loan is being offered by the Chase securities Corporation of New York and Messrs. E. H. Rollins and Sons in the form of 5-year 6½ per cent. external gold notes of the Ruhrverband.

The Ruhrverband is an association dating from 1913, which was formed for the purpose of purifying the Ruhr waterways, an important work in territory so highly industrialised. Among its members it includes the cities of Essen, Duisberg, Bochum, Muelheim and Oberhausen, together with the German Railway Company, United Steel Works of Duesseldorf, the Harpener Mines, Lorraine Mines, Goodhope Steel Works and the Ruhr Water Power Association.

ITALY'S COMMERCIAL FUTURE.

While certain difficulties, especially industrial ones, exist in the economic sphere, there is good ground for hope that the progress in Italy's commercial life will be strengthened, write Messrs. E. C. Donaldson Rawlins and H. C. A. Carpenter, British Commercial Representatives at Rome, in their Report on the Economic Situation in Italy. Among the countries exporting to Italy the United Kingdom moved from fourth place in 1926 to the third position last year, but more business in cheaper goods might be done.

CANADIAN CHEMICAL PRODUCTION.

A record value in the output of chemicals and allied products was attained in Canada last year, practically all groups showing an advance over 1926. Imports were also of greater value, with those from the United Kingdom somewhat in excess of exports to the Mother Country.

BRITISH IRON AND STEEL OUTPUT.

There was a fairly substantial rise in the production of pig iron during May and a still more satisfactory advance over April in the output of steel ingots and castings. Both totals were, however, far below May, 1927.

FIRE-DAMP EXPLOSIONS.

The flame of a fire-damp explosion is not necessarily confined to the region in which the inflammable mixture originally existed, but may be projected a considerable distance. It is of practical importance, notably in dealing with gob fires by stopping them off, to know how great this distance may be.

A laboratory study, employing tubes 5.5 cm. and 9 cm. diameter, and columns of explosive mixture 15 and 17 cm. long, was the subject of the Safety in Mines Research Board Paper No. 27, "Fire-damp Explosions: The Projection of Flame," Part I., by M. J. Burgess.

This research has been repeated on a larger scale in the 7ft. 6ins. diameter tube at the Board's Experimental Station at Buxton, employing columns of explosive mixture 26¾ and 53⅓ feet in length, and the details are given by the same author in Paper No. 42.

SAFETY IN MINES RESEARCH BOARD'S ANNUAL REPORT.

The Sixth Annual Report of the Safety in Mines Research Board, that for the year 1927, has just been published (H.M. Stationery Office, price 9d. net). As in previous years, the Report is mainly devoted to brief accounts of the progress of the numerous researches which are being carried out either directly under the Board or Committees of the Board, or at Universities and other centres with the aid of funds supplied by the Board.

FIELD WORK OF THE GEOLOGICAL SURVEY, 1928.

The Geological Survey of Canada will have over fifty parties, totalling two hundred and fifty persons, carrying on surveys and investigations in the field during the summer of 1928. There will be one party in Yukon, eleven in British Columbia, seven in Alberta, five in Saskatchewan, four in Manitoba, ten in Ontario, nine in Quebec, four in New Brunswick, and five in Nova Scotia.

As an aid to the development of the mineral industry of the country particular attention will be given to the examination of mineral occurrences and promising areas for prospecting readily accessible by present means of transportation. Information will be procured for the preparation of maps showing routes of travel, topography, mining claims, and the distribution of rock formations, and for the preparation of reports on the mineral possibilities.

Exploratory parties will also be sent to the more remote parts of the country to map the geographical features, make observations on the climate, the flora, and the fauna, and to investigate the geology, the minerals, the forests, water powers, and agricultural possibilities.

Surveys will be made of sections of country marginal to the Coast Range batholith, a great backbone of granitic rocks that extends the whole length of British Columbia and Yukon and is the source of most of the gold, copper ,silver, lead and zinc ore deposits that occur on either side of it. Studies will be made of the foothills of Alberta to decipher the structure of the sediments of Mesozoic and Palæozoic age with a view to ascertaining where conditions exist that are most favourable to the accumulation of petroleum and to render assistance in solving problems that are met in the mining of coal. Several parties will be engaged in the further study of the Pre-Cambrian formation, in which many of the large mineral deposits of Canada are found; these will include parties in the Rolyn area Quebec, where the Noranda smelter was started last December; in the Kississing Lake area, Manitoba, where the Sherritt Gordon property lies; and in the Reindeer Lake area, Saskatchewan, to which much attention has been attracted by recent discoveries. Parties will also be engaged in mapping and in the study of the mineral deposits of the Appalachian region, including Nova Scotia, New Brunswick, and South Eastern Quebec, a region rich in coal gypsum, salt, asbestos, and other useful minerals.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

On Thursday, June 14, the following papers were read in title only :—

The Anaerobic Delayed Heat-Production after a Tetanus. By A. V. Hill, F.R.S., and W. Hartree.

1. The anaerobic delayed heat-production after a tetanus has been re-examined, with stringent precautions to avoid the possibility of oxidation.

2. Its supposed long-continued part is due to a misinterpretation of the phenomenon described in a previous paper, *viz.*, the permanent increment in resting heat-rate produced by anaerobic stimulation.

3. Its earlier part is a genuine occurrence and is complete within a minute or two.

is very variable in amount, ranging from 5 to 46 per cent. of the initial heat. It starts at a high rate, and falls rapidly to a low value, being complete in a minute or two.

4. Its explanation is obscure: it may be due to phosphate changes known to occur after contraction and relaxation are complete; more probably it is to be attributed to the over-stimulation of some of the fibres of the muscle, a procedure known from the work of Meyerhof and his colleagues to produce a delayed formation of lactic acid.

5. There is no sign of an entothermic process occurring at any stage in, or after, contraction. The partial restoration of phosphagen after an anaerobis tetanus, as described by Meyerhof and his collaborators, must be regarded, therefore, rather as a "restabilisation" than as a "resynthesis."

6. We have been unable to verify a statement by Furusawa and Hartree that in purified nitrogen a muscle becomes gradually inexcitable, as a nerve is known to do. A muscle may give an excellent response after hours in the purest nitrogen, to which cyanide vapour has been added.

The Equation of Motion of a Runner Exciting a Maximal Effort. By C. H. Best and Ruth Partridge. Communicated by A. V. Hill, F.R.S.

Experiments in which external resistances of varying magnitude have been applied to a runner show that the maximum speed of the subject is decreased by the amount calculated from the equation of Furusawa, Hill and Parkinson. This is a satisfactory demonstration that the internal resistance of the muscles is real, in the sense that it has identically the same effect as an external added resistance.

Factors Determining the Maximum Work and the Mechanical Efficiency of Muscle. By A. V. Hill, F.R.S., and W. Hartree.

The "efficiency" $\left(\frac{\text{work done}}{\text{total energy liberated}}\right)$ has been examined for the case of a frog's sartorius muscle under various conditions; its maximum value, as the mean of 56 observations on 21 different animals, is 26 per cent., with an average deviation from the mean of only 2 per cent. This refers to the initial (anaerobic) process only: for the complete cycle (including oxidative recovery) the maximum efficiency is only 12½ per cent.

In man, the efficiency of muscular movement may be twice as great. In the frog the very low value is due to the extremely expensive nature of the process required p second to maintain a contraction. Contra tions of short duration, therefore, are nece sary and movement must be rapid. In rap shortening, however, muscle "viscosity plays a very large part in reducing the wo: done—74 per cent. of the mechanical ener of the initial process is degraded into hea In man, the maintenance of a contractic is far less expensive. Consequently, tl most efficient contractions are of conside able duration (1.3 seconds) and viscous r sistance absorbs a far smaller proportion the mechanical energy.

...Dynamics of Bicycle Pedalling. By Dickinson. Communicated by A. V. Hil F.R.S.

Recent studies of maximum speed muscular movements indicating that exte nal applied resistance would cause propo: tional diminution in the speed, the max mum speed of pedalling a bicycle ergomete has been determined as function of loa applied to wheel.

The relation between maximum spee and load is linear, speed decreasing as loa increases, according to equation $P = P$ $(1 - k/t)$, where P is force exerted on ped crank, P_0 "theoretical maximum force" attained only at zero speed, k a "viscosity" factor, the "theoretical minimum time," and t actual time of a single leg movement

The value of k was much the same in al subjects; P_0 the "strength" factor varie widely. It is deduced that bicycle pedalling like other movements involving overcomin external resistance, shows an optimum speed, at which mechanical efficiency i highest.

The Dictyoxylon Cortex of Lycopodiale as a Constituent of Coal. By C. A. Seyler. Communicated by D. H. Scott, F.R.S.

1. By the metallographic method o polishing and etching, the characters o secondary xylem in transverse, radial, and tangential sections of coal can often be observed.

2. The identification of periderm in coal cannot be safely based upon the radial seriation of the cells and the absence of the characters of xylem unless this negative evidence is supplemented by other features, such as characteristic disposition of sclerotic bands in periderm, etc.

3. A band of clarain in the Deep Soft seam of the Middle Coal Measures at Grassmoor Colliery, Derbyshire, has been investigated. The coal has a characteristic structure which is persistent over a considerable portion of

the band, which represents a single plant fragment or assemblage of fragments of one kind.

4. The band is shown to have the structure of a broken network of sclerotic fibres, enclosing in its meshes a thin-walled tissue, and to possess macroscopic and microscopic characters of a heterogeneous dictyoxylon periderm.

5. The structure is compared with that of various dictyoxylon cortices, from which those of Pteridosperms are excluded by the fact that the structure under examination is that of a periderm and not of a primary cortex.

On Clepsydropsis australis, a Zygopterid Tree Fern with a Tempskya-like False Stem, from the Carboniferous Rocks of Australia. By B. SAHNI. Communicated by A. C. Seward, F.R.S.

Clepsydropsis australis is the only member of the Zgyopterideæ known from the Southern Hemisphere. Several large specimens, recently discovered in rocks of the Kuttung Series (Carboniferous) of New South Wales, are described. These first figured specimens show the leaf-bearing axis and reveal an extraordinary type of stem organisation, comparable in broad features with that of the Cretaceous Fern *Tempskya*, and not previously observed in any palæozoic plant.

The trunk must have stood upright and attained a considerable height, with a reavy crown of foliage at the top; it was a " false stem " composed of numerous relatively weak, but erect, repeatedly forked leaf-bearing axes, which were embedded in a dense matrix of adventitious roots and aphlebiæ. In cross-sections of the trunk the individual stems, petioles, and in the peripheral parts of the trunk even the roots, are all cut more or less transversely. The peripheral roots appear to have formed a felt round the false stem, at least in its lower parts.

The origin of the leaf trace and its subsequent changes, the pinna trace and the aphlebiæ are described. The aphlebia trace often bifurcates precociously (in the petiolar cortex). Tbe twin strands, lying in the tangential plane ,recall the paired " pinna " traces (tertiary) of the Dineuroideæ. Nothing is known of a leaf lamina.

Experimental Researches on Vegetable Assimilation and Respiration.—XIV. By W. O. JAMES. Communicated by F. F. Blackman, F.R.S.

Determinations made by different workers of relation between concentration of carbon dioxide and rate of its assimilation by plants are not in agreement. The present paper records an attempt to find how far observed differences are due to different methods of presenting carbon dioxide to the plants.

Experiments are described in which carbon dioxide was supplied to *Fontinalis antipyretica*, in solutions with and without bicarbonates. The effect of moving both kinds of solution at different rates past the plant was also observed.

It was found that only with relatively rapid movement of the solutions was the assimilation rate independent of the presence of bicarbonate. The results are discussed in relation to the aqueous diffusion of carbon dioxide, and its effect on the photosynthetic process.

Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Fowl. By A. W. GREENWOOD. Communicated by R. C. Plunnett, F.R.S.

Four cases of successful implantation of testicular material from the hen-feathered strain of Campines into castrated Brown Leghorn males are described. The grafts produced the normal male head furnishings and behaviour, but did not lead to change in plumage character. These results are in accordance with those obtained by Roxas when testis from Sebright bantams was implanted into castrated Brown Leghorns, and support his conclusion that " hen-feathering " of male in hen-feathered breeds is due to endocrine difference between the two testes.

Successful implantation of testis from a Leghorn male into a castrated hen-feathered Campine did not result in change in plumage as would be expected on basis of above hypothesis. It is suggested that failure of the graft to change type of feathering was due to insufficient amount of testis, since it was incapable of inducing normal development of head furnishings.

Reatlionships Between Chemical Composition of Vegetable Seed-Fats and their Botanical Origin. By T. P. HILDITCH. Communicated by E. F. Armstrong, F.R.S.

Results of recent analyses of mixed fatty acids of various seed-fats from some *Palmæ*, *Cruciferæ* and *Umbelliferæ*, together with earlier data on other members of these orders and of the *Myristaceæ*, are subjected to detailed comparison.

It is shown that in any one of these four orders the composition of the fatty acids of the seed-fats is of the same general type, but that each order is marked by definite,

and specific characteristics in the composition of the fatty acids. Thus the Palmæ seed-fats almost always contain 46 to 50 per cent. of combined lauric acid, with minor amounts of capryilc, capric, myristic and palmitic acids and relatively small proportions of oleic acid; in the Myristaceæ seed-fats myristic acid predominates; in Cruciferous seeds there is usually 40 to 50 per cent. of combined erucic acid, the remainder consisting of oleic and linoleic acids in varying proportions; and finally, Umbelliferous seeds appear to be characterised by the presence of an isomeric form of oleic acid, petroselinic acid (20 to 75 per cent), not yet observed in seed-fats of any other order, except the closely related Araliaceæ.

It is inferred that seed-fats of any given botanical order have certain characteristics of their own, differing from those of dissimilar orders.

THE PHYSICAL SOCIETY.

Proceedings at the Ordinary Meeting following the Special General Meeting on May 25, W. H. Eccles, D.Sc., F.R.S., in the chair:—

Contact Potential in the Dolezalek Electrometer Connected Idiostatically. By L. F. Richardson, F.R.S., and Students of Westminster Training College.

Abstract.

It was found that the deflection x was related to the voltage V by the formula

$$x = k\{\tfrac{1}{2}V^2 + \eta\},$$

k being constant from month to month, but η varying from 0.3 to 1.2 volts on different days. If it is desired to measure V it is therefore essential to reverse the polarity in order to climinate η.

Discussion.

Dr. Ezer Griffiths: I should like to ask the author whether he has made experiments to determine what factors may account for the changes observed in the values of the contact potential. In some experiments on the ionisation current for various applied potential differences between two aluminium electrodes cut from the same slab of metal I had trouble with contact potential effects, and found that heating one of the plates would produce marked changes. If one of the electrodes was heated and allowed to cool slowly a smooth curve relationship could be obtained between the contact potential and the temperature. The curve was not always reproducible, and after the electrode had cooled down to air temperature the value of the contact potential changed as a slow rate Similar effects were observed with electrodes of other metals, such as zinc. In these experiments the electrodes were in an enclosure containing air dried with calcium chloride. Although the variations in the value of the contact potential were fractions of a volt, they were readily measured with the Compton electrometer. In view of the complexity of the phenomena, it would be useful to have the experiences of other workers who have encountered similar troubles.

Mr. R. W. Paul said that he had found it possible to eliminate contact potentials almost completely in the electrometer by making all the plates from the same piece of aluminium and baking them in a moist atmosphere.

Mr. G. L. Addenbrooke said that he had avoided contact potentials by using heavily gilded quadrants and a heavily gilded mica needle, aluminium not being employed. He had also designed an electrometer in which the conductors were made from the same piece of metal and brought to the same condition by heating and annealing. A double needle and eight quadrants were used astatically, and the deflection due to contact potential was thus reduced to 2 mm. or 3 mm. It depended on humidity, and was subject to long-period changes.

Dr. E. H. Rayner said that in his laboratory it was the practice to calibrate electrostatic voltmeters with alternating current. A Kelvin instrument with aluminium needle and brass quadrants was found to give a contact potential of about 0.36 volts, and the substitution of aluminium for the brass made matters worse. By careful attention to the condition of the surfaces the contact potential had been reduced to 0.05 volts or 0.15 volts, but it varied with the weather. It might be convenient to eliminate it by applying a correcting voltage to the quadrants.

Mr. A. P. Castellain said that at East London College it had been found that asymmetry of readings could be almost entirely eliminated by ensuring coincidence of the electrical zero (determined by joining the quadrants and applying a high voltage to the needle) with the mechanical zero. The asymmetry in the case in question amounted originally to 0.08 cm.

Mr. W. E. Benham said that as the electrostatic voltmeter was more often used for A.C. than for D.C., it was important to know to what extent A.C. readings would be affected by the errors discussed in the paper. The accuracy varied with frequency,

the resistance and inductance of a silvered quartz suspension filament having appreciable effects at radio frequencies.

Dr. D. Owen quoted references to the subject-matter of the paper in Laws' "Electrical Measurements," and Moullin's "Radio-frequency Measurements." For use in A.C. measurements electrostatic voltmeters must be calibrated with A.C. voltage (Paterson and Rayner, Journ. I.E.E., 1913). A British Association report on the Voltaic cell by Sir Oliver Lodge (1884) indicated the puzzlingly indefinite character of the contact potential of about 1.5 volts. The discrepancies disappeared with the use of A.C. voltage.

Dr. L. F. Richardson: I communicated the paper with some diffidence, expecting to be told that it was not new. The references mentioned by Dr. D. Owen will be useful. In reply to Dr. Ezer Griffiths, I suspect humidity to be a cause of the variation of η. Prof. Porter has chosen the Volta effect as the subject of his Presidential Address to Section A of the British Association, and we may expect further enlightenment on this question then. In reply to Dr. Addenbrook, Dr. Rayner and Mr. Paul, who have described processes for making η small, it is satisfactory to know that, even if they do not quite abolish η, yet η could be simply and accurately eliminated by reversing the polarity. In reply to Mr. Castellain, I would point out that 0.03 cm. is small in comparison with the 6 c.m. mean deflection produced by the same voltage applied idiostatically. In reply to several speakers who were chiefly interested in alternating currents, the second member of equation (5) is proportional to the electrostatic couple when the vane is in equilibrium. When subject to an alternating E.M.F. the vane is not in equilibrium, except at two instants per cycle. But the classical theory, from which (2) is derived, when pursued further shows that the electrostatic couple is independent of the position of the vane; and although this theory fails when A and B are large, yet it has been shown in §2 to be satisfactory for the idiostatic connection. Hence the equation of motion of the vane is

$$\theta = k_1\{\tfrac{1}{2}V^2 + V\eta\} + Id^2\theta/dt^2 \quad . \quad . \quad . \quad (12)$$

where t is the time and I is a constant times the moment of inertia. Integrating over a period of oscillation T, we have

$$\frac{1}{T}\int_0^T \theta dt = \frac{k_1}{2}\frac{1}{T}\int V^2 dt \quad . \quad . \quad . \quad (13)$$

the term in η vanishing provided

$$\int_0^T V dt = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

That is to say: Whatever the contact E.M.F. may be, the mean of the deflections for V and $-V$ applied steadily is the same as the mean deflection for an alternating E.M.F. of effective value V, provided that there is no resultant direct E.M.F. applied. Here V is the potential at the foot of the suspension.

Some Experiments on the Light-Sensitivity of Commercial Selenium Cells. By GEO. P. BARNARD, The National Physical Laboratory.

ABSTRACT.

Part I. The Relation Connecting the Change in Conductivity of Selenium Cells with Illumination.

As the result of an experimental investigation, it is shown that the change in conductivity C due to a given intensity of illumination I is proportional to some power of the illumination I— *i.e.*, $C \alpha I^x$. The index value x varies from cell to cell, and is probably dependent on the construction of the cell. A sensitivity curve is given.

Part II. The Reaction of Selenium to Various Spectral Regions.

Some filter experiments are described in Part II, from which it appears that the change in conductivity of selenium cells is dependent, not on the number of foot-candles incident on the cell, but rather on the amount of radiant energy received. Contrary to general belief, it is shown that, for the same amount of energy received, the action of the infra-red is relatively much weaker than that of the shorter wave portion of the spectrum.

Some experiments on the decay of conductivity of selenium after exposure to radiation from various portions of the visible spectrum, the internal state of the selenium, as determined by the change in conductivity, is independent of the wave-length of the exciting radiation.

A brief note on the nature of the light-action in selenium cells is added.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, April 27; William Stone, M.A., F.L.S., F.C.S., Manager, in the chair:—

Carriers of Electricity in the Atmosphere. By ARTHUR M. TYNDALL, D.Sc., F.Inst.P., Professor of Physics, University of Bristol.

A certain amount of information on the nature of ions in the lower atmosphere may be gained from a study of their motion in an electric field. Except in special cases, which rarely arise at ordinary pressures, the motion of an ion through the air is analogous to the motion of a sphere falling through a viscous liquid. This motion is one of uniform velocity, the value of which depends upon the radius of the sphere, the force acting upon it and the viscosity of the liquid.

The nature of ions in air has been a subject of study for more than thirty years, but our information is still incomplete, and a variety of phenomena still require elucidation.

For a given force and medium the larger the sphere the slower it moves. This may readily be demonstrated in a syrupy liquid by dropping into it two balls, one of lead and the other of aluminium, their relative sizes having been selected so that they have equal weights in the liquid.

Similarly ions in air possessing the same electric charge, but having different sizes, will move in an electric field at different rates, the larger one travelling slower. There are theoretical grounds for supposing that this factor of size, though not the only one, is of great importance in determining the motion of the ion.

Some interesting effects may be obtained by adding small quantities of an organic vapour to the air. Let us take, for instance, the series of normal alcohols of chemical composition $CH_3(CH_2)_nOH$ where $_n$ may be zero or an integer. The molecules of these substances are known to be rod-like in shape the length of the rod increasing with increase in the carbon content, *i.e.* with the value of $_n$. They are also known to be polar, a property presumably mainly due to the OH group made up of a positive hydrogen nucleus and a negative atom of oxygen. For the purposes of a rough static model these molecules may therefore be thought of as having an active head and a more or less inert tail, and they will be attracted to a negative ion with their heads inwards towards the ion and their tails spread out radially.

The effective size of the ion will thereby be increased by an amount which depends on the length of the molecules of the particular alcohol added.

Experiments by the lecturer and L. R. Phillips have shown that for a given vapour pressure of alcohol the reduction in mobility of an ion increases rapidly with increase in length of alcohol chain. Thus the highest alcohol (Amyl) used in this work, though present as only one part in 300 of air, reduced the mobility of the ordinary negative air ion to about 40 per cent. of its normal value.

The effect on positive ions is nothing like so marked, though it is observable. This may be attributed to a weaker bond between the dipole and a positive ion, because the positive end of the dipole cannot approach it so closely.

By adding water vapour as well as alcohol vapour to the air there is now a competition for places at the ion surface, so that short water molecules replace some of the longer alcohol molecules. We should on this view expect a rise in mobility of the ion, and this is observed.

If the molecules are made non-polar by removing the OH group and making them symmetrical in structure, the tendency to cluster on the ion should be almost entirely removed. This has also been confirmed by experiment ,since it has been found that the hydrocarbon decane with ten carbon atoms, and therefore of length roughly twice that of amyl alcohol molecules, has practically no effect on the motion of the ion in air.

New methods for measuring mobility have been devised with the special purpose or deciding whether all the ions move with the same speed, Considerable resolving power has been achieved. The negative ions appear to be of a single kind in air containing appreciable quantities of vapour. The positive ions over the same range, and the negative ions in the presence of small traces of vapour, appear to be more complex. Certain features present themselves which the still the subject of investigation.

A lecture demonstration of the loading effect of alcohol may be conveniently made by applying a small voltage to an ionization chamber, so that the ionization current is well below saturation. By blowing alcohol vapour into the chamber the current is reduced to about half, due to the reduction in mobility of the ions conveying it. The ionization current may be amplified by a valve method so that it is recorded on a galvanometer.

In the ordinary atmosphere complicating factors are introduced by the presence of particles of dust, smoke, mist, and other nuclei. A number of small ions will attach themselves to these, and will then move so slowly that their contribution to an ionization current is practically negligible. In the demonstration referred to above this may be readily shown by blowing tobacco smoke into the chamber, when the ioniza-

ion current to all intents ceases. In addition to the production of large ions by the union of small ions with nuclei, large ions may also be produced by splashing and breaking up of water-drops, by frictional effects in dust storms, and so forth. The presence of these large ions has marked local effects on the potential gradient at the earth's surface and the value of the air earth-current at a given place. Certain fluctuations in these values have been correlated with variations in the number of nuclei present.

When ions of a given sign are dragged through a gas by an electric field they set the air in motion. With the relatively intense ionization current from an electrified point, this gives rise to the well-known phenomenon of the electric wind. One of the earliest methods of measuring the mobility of ions was based upon a study of this phenomenon.

Again, if a discharge of this type takes place in a smoky atmosphere the electric wind assist in carrying the charged smoke particles towards the surrounding surfaces, where the particles stick on impact. In other words, it acts as a smoke precipitator.

To sum up, it may therefore be said that the subject of atmospheric ions has a bearing on at least two important problems at the present time. Firstly, there is the problem of the mode and mechanism of attachment of molecules and ions, linking up with allied problems in the structure of bodies in general. And, secondly, there is the wide field of meteorology and the problem of atmospheric electricity in particular.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, July 2, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The Secretary reported the death of Professor Theodore Richards, an Honorary Member, and a resolution of condolence with the relatives was passed. Mr. E. E. Jelley and Mr. A. Marshall were elected Members.

GEOLOGICAL SOCIETY.

A Note on the Pleistocene History of Western Buchivacoa (Venezuela). By John Parkinson, M.A., Sc.D., F.G.S.

The area consists of alternating estuarine or freshwater false-bedded sandstones, and sandy clays, folded along east-north-easterly axes in many places. Burdigalian and centres of the folds. There is an unconformity between the Miocene and the overlying strata, which appear to be of Lower or Middle Pliocene age.

The Tertiary deposits are covered by Pleistocene pebble-beds. The latter are probably an old sea-beach. Subsequent elevation during a pluvial period allowed of a "creep" of the pebbles northwards. Redeposition in successive stages was effected by eastward-flowing rivers of the Indus type.

Since Pliocene times, an elevation of about 1,000 feet has taken place along the southern edge of the district.

Gyrinodon quassus, a New Genus and Species of Toxodont from Western Buchivacoa (Venezuela). By A. Tindell Hopwood, M.Sc., F.L.S., F.G.S., with a note on the Reptilian Remains by William Elgin Swinton. B.Sc., F.L.S., F.G.S.

Diagnosis.—Toxodontidæ of medium size. Frontal region passing gently into the anterior portion of the temporal fossa. Postorbital processes greatly reduced. Neither the superior margin of the orbit nor the roof of the nasal chamber is inflated. Upper lateral incisor curved in an arc of 180° or more. First and second upper molars with a slight metaloph; third molar with long concave ectoloph, but no metaloph. Mandibular symphysis not extending backwards to the second lower molar. Third lower molar witnout a second, posterior, fold in the enamel lingual surface.

Remarks.—*Gyrinodon* differs from *Toxodon* in its more primitive dentition, and in the characters of the skull-cap. It differs from *Alitoxodon* in the characters of the mandibular symphysis.

THEORIES ON BINARY AZEOTROPIC MIXTURES CONTAINING LOWER ALCOHOL AS ONE COMPONENT.

By Yoshi Tanaka and Tsutomu Kuwata.

The vapour pressure of binary liquid mixture, containing lower alcohol as one component, shows in many cases the marked deviation from the Raoult's law and the phenoment of an azeotropic mixture is often found.

The authors have proposed some rules on the change of the compositions of the azeotropic mixture by pressure or temperature. These rules start from the conceptions that the molecules of alcohol which is a polar compound, are surrounded by a special polar field and the polar molecules exhibit an abnormal attraction for one another and repul-

When the vapour pressures of pure components I and II are denoted by P_I and P_{II} respectively, the authors' rules are as follows :—

(1) When the pressure or temperature changes so as the ratio of P_I / P_{II} increases, the composition of the azeotropic mixture always changes as the ratio of $n_1 / 100 - n_1$ increases and vice versa, where n_1 is the per cent. content of component I in the azeotropic mixture.

(2) When the ratio of $P_I P_{II}$ becomes larger or smaller than the definite range of value which is proper to the mixture, there occurs no phenomena of an azeotropic mixture, if the vapour pressure still deviates remarkably from the Raoult's law.

The rules are true to all azeotropic mixtures of lower alcohols which have ever been observed, such as ethyl alcohol-hydrocarbons, ethyl alcohol-ethyl acetate, ethyl alcohol-water, methyl alcohol-hydrocarbons, propyl alcohol-water, butyl alcohol-water, and others.

Applying Clausius-Clapeyron's formula to the above rules, the following rules are also derived.

(1) When the pressure or temperature increases, the component which increases, has always greater heat of vaporisation than the other.

(2) Two substances which have the same heat of vaporisation at the same temperature can form no azeotropic mixture.

The phenomena known as Bancroft's rule can be explained by the above second rule.

The authors remarked also that when the change of the composition of an azeotropic mixture by pressure or temperature was considered, the latent heat of vaporisation or entropy of vaporisation ought to be considered and that the value of dP/dT which was considered by Merriman, is not able to explain the azeotropic mixture of ethyl alcohol and water.

ANALYSIS OF A MIXTURE OF WATER, NITRIC ACID AND SULPHURIC ACID BY THERMOMETRIC TITRATION.

By Takayuki Somiya.

When a mixture of water, nitric acid and sulphuric acid was thermometrically titrated with fuming sulphuric acid, two end-points were recognised. The first one was sharply noticed when the solution changed to a mixture of H_2SO_4 and $SO_2(OH)(ONO_2)$ according to the equations :

$$SO_3 + H_2O = H_2SO_4 \text{ and } SO_3 + HNO_3 = SO_2(OH)(NO_3)$$

The second one was obtained about when $SO_2(OH)(ONO_2)$ changed to $(SO_3)_4N_2O_5$ according to the equation

$$2SO_2(OH)(ONO_2) + 3SO_3 = H_2SO_4 + (SO_3)_4N_2O_5$$

but it was not distinct, although it was somewhat sharper as the concentration of fuming sulphuric acid increased. From the amount of standard solution that was added until the first end-point was reached, the sum of amounts of water and nitric acid was calculated. An approximate amount of nitric acid was calculated from the amount of standard solution required between the two end-points.

It was neither simple nor accurate to estimate accurately both nitric acid and the sum of water and nitric acid by determining two end-points in one constiuous titration and there were many difficulties in the procedures and the construction of the apparatus when the highly concentrated fuming sulphuric acid was used as the standard solution.

When the above acid mixture was titrated with fuming sulphuric acid containing nitric acid, only one end-point was sharply recognised. The point was reached when the solution became a mixture of H_2SO_4 and $SO_2(OH)(ONO_2)$, therefore the sum of water and nitric acid contents was determined with an accuracy equal to that of the determination of water content in sulphuric acid. The analysis was based upon the following equations :

$$(SO_3)_4N_2O_5 + 3H_2O = 2H_2SO_4 + 2SO_2(OH)(ONO_2)$$

$$(SO_3)_4N_2O_5 + H_2SO_4 + 3HNO_3 = 5SO_2(OH)(ONO_2)$$

CORRESPONDENCE.

LOCAL AUTHORITIES AND THE SMOKE PROBLEM.

To the Editor of The Chemical News.

Sir,

In view of the recent recommendation of the National Smoke Abatement Conference that local authorities should investigate the supply and suitability of various smokeless fuels as a means of mitigating the domestic smoke evil, the experience of the West

Riding of Yorkshire Regional Smoke Abatement Committee may be of help to both administrative bodies and the public.

Ever since this Committee was constituted three years ago, it has endeavoured to discover some method of reducing domestic smoke, which is generally acknowledged to provide the greater part of the suspended solid matter in the air. We have naturally been extremely cautious in regard to any general recommendation, but after a most careful investigation we are convinced that low temperature carbonisation has now reached a state of development where solid smokeless fuel is produced commercially at a price which, having regard to bulk and thermal efficiency, can be recommended to the public as an adequate and economical substitute for coal.

In arriving at this decision, the Committee has been particularly influenced by the result of its investigations into the commercial production of smokeless fuel in Yorkshire. Practical tests of the burning of such fuel, conducted under various conditions—in a well grate, an old-fashioned bar grate, an old type of Yorkshire range, a modern kitchen range, and a sectional boiler—all gave highly satisfactory results.

Trusting that this experience will be of benefit to any local authority or Smoke Abatement Committee which is endeavouring to give effect to the recommendations of the Conference,

I am, Sir, etc.,

(Signed) J. Johnstone Jervis,
(Hon. Sec., West Riding of Yorkshire Regional Smoke Abatement Committee.)
Public Health Department,
Leeds.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Pedler Research Scholarship.

The Council of the Institute of Chemistry has decided to utilise the income from the legacy bequeathed to the Institute by the late Sir Alexander Pedler for the provision of a Scholarship to be known as the Pedler Scholarship.

The Scholarship will be of the value of £250 per annum, and will be open to Fellows and Associates of the Institute.

The Scholar will be required to undertake work on a problem or problems to be chosen by the Council. In selecting the problem the Council will have regard to the need for its investigation in the public interest.

The Council invites Fellows and Associates [illegible] suitable problems for investigation under this scheme, and will be glad to receive such suggestions. The Pedler Fund Committee will announce the problem and will invite applications from candidates for the Scholarship. The selected candidate will be informed of his or her appointment before 1 October, with a view to commencing work as soon as possible after that date.

Examinations.

The next Examinations will be held at the Institute on the following dates:

For the Associateship — From 17-22 September.

For the Fellowship—From 24-29 September.

The last date for entry is Monday, 16 July. Regulations and forms of application can be obtained from the Registrar of the Institute, 30, Russell Square, London, W.C.1.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

16,888.—Chemical Construction Co.—Concentrating nitric acid. June 11th.

17,500.—Cottet, E. C.—Condensation products of polyphenols and formal. June 16th.

16,945.—Exley, W. H.—Apparatus for elevating acids, etc. June 12th.

17,007.—Gault, H. — Manufacturer of chloracetic cellulose esters. June 12th.

17,189.—Schering-Kahlbaum Akt.-Ges. — Manufacture of lactic acid esters. June 14th.

Specifications Published.

291,825.—I. G. Farbenindustrie Akt.Ges.-Manufacture of new vat dyestuffs containing sulphur.

271,528. Grenier, R. J. A.—Catalytic process for the manufacture of hydrogen.

288,127.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of acid- and lime-resisting derivatives of unsaturated fatty acids.

291,886.—I. G. Farbenindustrie Akt.-Ges. —Nitration of anthrone and the preparation of 2 : 7 dinitroanthraquinone.

Abstract Published.

289,412.—Nitrogen oxides.—Elektrizitatswerk Lonza, 72, Aeschenvorstadt, Basle, Switzerland.

Nitrogen oxides are absorbed from gaseous mixtures such as those obtained by the oxidation of nitrogen or ammonia by treatment in stages with nitric acid of increasing concentration at temperatures below 0° C. and preferably at -20° C. to -30° C. In the first stages the lower oxides of nitrogen decompose the nitric acid to form nitrogen peroxide which is absorbed in concentrated nitric acid in the final stages. The liquid from the first stages may be reconverted into nitric acid by treatment with oxygen, and that from the final stage may be separated by fractional distillation into concentrated nitric acid and pure nitrogen peroxide. Nitric acid vapours in the effluent from the final stage may be absorbed to produce solid nitrates. The treatment of the gases with nitric acid may be effected in centrifugal washers.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

REGESAN.

489,459.—Chemical substances used in photography.—Boots Pure Drug Company, Limited, 87, Station Street, Nottingham. June 20th.

REGEPHOS.

489,457.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. June 20th.

REGASPIRIN.

489,453.—Aspirin and preparations compounded principally with aspirin, all for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. June 20th.

REGOIDS.

489,452.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd.,

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GENERAL INDEX TO THE " CHEMICAL NEWS "—VOLS. 1 TO 100.

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SCIENCE TRAINING IN SCHOOLS.

By ROBERT SAXON, B.Sc., F.C.S.
Member of the American Chemical Society.

WEIGHING BY WATER DISPLACEMENT.

This is easily effected in a variety of ways using test tubes in the same way as with the hydrometer. To make a test tube sink to the same mark by means of a body and by weights is a direct means of weighing by substitution, and requires no expert skill in rigging up the apparatus. It should be practised by youngsters before they attempt to understand specific gravity. The theory of specific density as taught by Nicholson's Hydrometer, so plain to science teachers is not so to beginners. These have too much to grasp for a start. They must visualise the following :—

1. The weight of the body in air is the same as that of the substituted weights.
2. The weight in water is less than this.
3. The body is preventing the weights at the top pushing the instrument down to the mark.
4. The body is making some effort to rise, that effort being shown by the difference in weights.
5. The body must be " standing " on something to push upwards, or in other words something must be pushing it up.
6. The water level at the surface is higher than it was before the body was immersed, and this extra water could not be lifted unless an equivalent force kept it lifted.
7. This potential water pushing downwards *pushes on the top* of the body, sides, *and bottom.*
8. The side thrusts balance one another. This is not easily seen with irregular bodies.
9. The bottom is lower than the top (of the body), and the up-thrust must be due to *this difference in height.*

Thus it will be seen that for a student to see what really happens is not by any means simple, even if he has been shown that the body displaces its own weight of water, and also that water transmits pressure equally in all directions. It is not easy for him to see the water handing on this upthrust *round* the body, and not in any way pushing the object downwards, seeing that it is actually pressing on that part which tends to send it down, namely, the top. We are too ready to imagine that a student has formed a *graphic concept* of the *sequence* of reactions taking place in an experiment, simply because he writes :—

Weight of body in air	... ...	xxxx
,, ,, ,, *water*	...	xxxx
,, *of water displaced*	...	xxxx
Specific Gravity	... ...	xxxx

He has simply followed instructions, seen that his weights were clean and dry, that air bubbles kept away from the immersed body, that the instrument did not sway and grip the cover-hole with resultant friction, and that he has kept his notebook neat and clean, arriving at a result like the answer to a guessing competition. Whether or not the right number be arrived at will not help him to see why he has been working the experiment. It is a little easier to understand specific gravity by weighing cubes of different materials of the same size, and such cubes and irregular pieces of the same materials, the volume of these latter being found by displacement, and such attempts should precede these arriving at specific gravity by weighing in air and water. The air and water methods should be approached gradually, and then used at first with materials whose specific gravities are known. For these direct findings cubic centimeters should be used, not cubic inches, as our apparatus is graduated in the metric system. *Such an observation is necessary* from the fact that at an exhibition of scientific apparatus last week cubes of metal and wood were shown of one cubic inch, though there was no means of weighing a cubic inch of water. These cubes may be dropped into a measuring cylinder to render familiar the displacement of water. Their weight in water can be shown to differ from their weight in air by the weight of an equal bulk of water. Once these elementary principles are clear it is pleasant to consider irregular bodies and other liquids. It is inviting muddle to attempt to make these principles clear by means of broken magnitudes.

Upthrust of Water Varies With the Depth.

One of the many means of measuring the depth of a liquid in a tank is by pushing a vertical tube closed at the top and open at the bottom down to the bottom of the tank. The amount of force necessary to do this varies with the depth and is an indicator thereof. Another consists of a tube open at the bottom as in the first case and bending over at the top communicates with a pressure gauge. The reading on this varies with the depth, for the air *imprisoned in the tube* will be compressed by the outer liquid. *wards into a liquid. Note that the resistance increases with the depth.* Never mind about mensuration in fixing the first step towards the truth. Dealing with intangible decimals with abundant chances of misplacing the decimal point discourages the main essential and often frightens it away. In a great number of such laboratory class work the blunderers, like many a class of tuneless choristers, have to depend entirely on the leaders. As far as their experience has led them they might as well have been told the truth at the beginning, for their results have not been considered, but those of others more lucky than they. Here they can appreciate this first truth by gently "bobbing" the tube up and down at different depths. Knowing that their experience is common they will feel a common impulse to pursue the quest.

Now press into service small objects that just slide easily down a tube, of the same size and shape like *steel bearing-balls* and *tabloids* like those of potassium chlorate. Drop such one after another into a closed tube floating in water. Note the fact that the *upthrust of the water increases regularly with the depth.* Pieces of wire may be cut and finished to the same length, shown to have the same unbroken weight such as one gram, to fit easily in the floating tube, and used to confirm the law. The student is now armed with the principle which will tell him that his calculations are right or wrong in future experiments, and not leaving him groping helplessly, hoping that his figures are right, as would be the case did he not know the basis of his research. Mercury could of course be used, and has a kind of priority way of suggesting itself, but it is not easily delivered in predetermined quantities. To weigh it for each addition would make the experiment tedious without any reason therefor, and necessitate readings on the scale untrustworthy as taken through the water. Coloured water densified by a heavy salt is better as this may be taken in equal bulk for each addition. It may here be mentioned that the water-jet apparatus, though placed high upon a shelf gives a good illustration of the motions of translation and gravitational acceleration, does not deal with upthrust, and removes the point of debate outside the vessel. Besides, the student does not easily see that the velocity of horizontal displacement is uniform, and he is not called upon to note that the *pressure depends directly upon the depth.* Be it noted also that this depth changes all the

Now come to closer grips with the water by taking cylinders of equal unbroken weight drilled to hang centrally on a fine wire as support. By weighing these in the water adding one at a time it will be seen that the ratio between the weights in water and air remains the same throughout, and *is not the result of one experiment.* What is equally important will be noted namely that *the water level rises regularly*, and *the depth to the bottom of the lowest cylinder increases regularly* in conformity with our law. Now is the student ready to make the usual experiments with bodies of any shape and of broken sizes, introducing decimals, and bringing in other decimals in calculation and note, which decimals will be watched to see that they do not set the laws already fixed at defiance. He now will let his mental observation enter the water and see the forces there at work.

This is but one example of approaching the laws generalising scientific phenomena. They took generations of philosophy and patient probing to round up. The student should not be expected to re-delve them from a few experiments in a few terms in a laboratory unless he be carefully led to reason for himself in terms of carefully graded difficulty. Otherwise he loses heart or his understanding gives way, like a young athlete does when initial jumps are set him which exhaust his strength.

Boyle's Law.

As the pressure in a liquid increases regularly with the depth in pressing down a tube of air closed at the top we may illustrate Boyle's Law. By taking liquids of different densities we may make manifest their relative densities and the law. In all these experiments we need a containing vessel as tall as possible. By welding a glass pan to the closed end we may by equal increment of weight placed thereon make the law clearer still. In the same way glass tubes may be fixed vertically to the under side one to each pan of a balance. These dipping into water serve as dampers to the swinging of the balance and the difference in dip between the two when the balance has finished swinging serves to shew the small difference in weights upon the pans. Graduated tubes of this description serve to show quickly the end point in weighing. A U tube bent so that the distance from the centre is equal in swinging, and fixed to the centre of the beam, has one end closed and contains a coloured liquid or mercury to rest in the middle when the balance is at two pans will push the liquid to one side and compress or ease the pressure on the air in the closed end according to Boyle's Law, and by graduation the tube may record the amount of this difference. The liquid in this case also serves as damper. The tube must be shaped so that with small swing the glass in either side of the centre balances with the other. There is a piece of apparatus for illustrating Boyle's law whereby air is compressed in a tube by means of a bicycle pump pushing on a column of mercury shewing the volume. A pressure gauge is attached to indicate pressure. Such an arrangement does not illustrate Boyle's law, insomuch as the student does not see how the gauge works. Even with Mariotte's tube the mercury is not weighed, and the student does not know whether or not the liquid is compressed at the bottom end, in the neighbourhood or the air. If the air is squeezed why not the mercury? Has he been shown why not? Can he reason and say that no weight would compress it? Why not add the mercury in equal quantities by volume instead of pouring in to a mark?

"Chainomatic System" Balance.

This system affords a good example of balancing columns a chain of links taking the place of a chain of mercury in Mariotte's tube for illustrating Boyle's law. The working of the system is well illustrated in the catalogue of Messrs. F. E. Becker and Co., Ltd., a good example of vernier reading being shown at the side. The chain comes to rest within the region of 100mgm difference between the pans, and does away with the necessity of using small weights or riders. It may be tested at several points within the region. It has a great advantage over small weights insomuch as there is nothing to handle or corrode. As the reading may be taken with the cover down the whole is less subject to acquire filth and corrosion than a set of weights. It seems to be a case of straining at gnats and swallowing camels where great pains are taken with a rider to ascertain a weighing to .00001gm. with a set of brass weights obviously carrying dust and tarnish.

Direct Reading Balances.

Generally Specific Gravity balances such as the Westphal work by means of riders acting against a counterpoise. These illustrate the principle of moments, but their working is not understood very easily by the student who is inclined to accept their decisions as he does those of a watch;

Reading Specific Gravity Balances with sliding weight and pointer which replaces riders work by the fact that as the hydrometer sinks in the liquid it swings away from the centre, and comes to rest at the point on the scale indicating the specific gravity of the liquid. There are balances which do away entirely with the fractional weights by riders on the beam. As these may be slid along with the case closed they should be better than weights. Iit is however no easy matter to make a " monkey " sit on the beam astride rectanularly, and many devices are employed to make him do so. One form of rider has a point support sliding in a groove along the beam, and as the rider is symmetrical the legs dispose themselves equally on either side of the pivot, and keeping the centre of gravity low maintain equilibrium. Balances with sliding ring weights offer good illustrations of leverage, and may be modelled in timber in the laboratory. The theory of their working affords a good introduction to the weighing machine. Such pieces of apparatus as the lever letter scale indicating weight by the radial displacement from the vertical of the pointer over a scale, afford an illustration of the method of estimating small fractional weights by the displacement from the zero of the pointer in the ordinary balance, and the study of the action of the pointer on the sensitiveness of the same. If a removable pointer be employed which may be weighed, and whose centre of gravity found, the theory connecting the pointer reading, added weights, and pointer moment, may be studied directly.

Lecture Demonstration Balances.

These should carry a pointer blackened moving in front of a scale whose 5 divisions are alternately coloured red or blue and white. Such scale should be broad enough to be seen brom the back row of benches above the table level. It should be specially illuminated and if possible magnified laterally by means of a glass "cylinder." Many such balances are in use which cannot be seen and read by normal sight four yards away. Polished brass is most distressing to stare at, as most brass turners know to their sorrow. Yet there are many scales with vernier attached in burnished brass, or German silver, which when viewed through the small microscope the instrument carries, can only be seen clearly with illumination from one angle, and finding this angle makes the eyes ache. Brass, either old or new, is unsuitable for scales as it corrodes easily, and new, its yellow reflection is injurious to the eyes. The marks on any metal scale can only be easily made out when filled with filth. Metallic lustre is so generous that it comes as readily from the sides of a groove as from the top, killing definition. As the eyes are straining when reading a scale they should not have to look on a dazzling background. For this reason the general tone of a scale should be sober, with the lines in white. This can be got by etching through a dark laquer or plating to a background of white or shining metal underneath. White celluloid is much better than any metal, and ground glass double scale better still. This latter consists of two scales one in front divided finely, the one behind only at the big points, but not the subdivisions, and the pointer swinging between the two. If the two are accurately mounted so that the big points coincide, these will reinforce one another and stand out visibly. These also serve to make the reader take a proper position directly in front of the scale, and aberration is avoided. The end of the pointer will of course reach below the front scale, but not helow the one behind whose big points will be seen below the front scale, as the rear scale will be broader than the one in front. The subdivisions may be added to the back scale along the bottom of it.

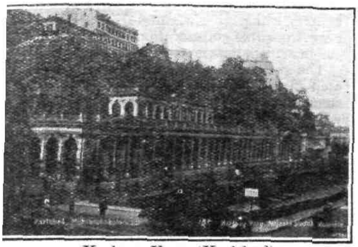
The College Lecture Balance whose chief use is to illustrate water displacement, should for this latter purpose have pans alike. When the student sees a short pan over the water he is apt to remember that the water side was lighter than the other, and think that it was due to the lesser pan. The necessary wires, hooks, etc., should be duplicated to counterpoise, and the only things to watch the cylinder and the water placed in the hollow cylinder to balance the upthrust of the water in the jar.

SULPHUR AND MUD BATHS IN CZECHOSLOVAKIA.

By J. G. F. Druce, M.Sc.(Lond.), R.Nat.Dr.(Prague), F.I.C.

It has already been mentioned in *The Chemical News* and elsewhere (1) that Czechoslovakia possesses about 200 enrative and thermal watering places. The majority owe their popularity to the healing powers of their natural mineral waters which are often rich in saline contents as well as being distinctly radio-active. Thus the Karlsbad Sprudel waters contain sodi-

um sulphate, bicarbonate, etc., and the waters at Poděbrady contain the chlorides and bicarbonates of lithium, sodium and iron.[1]



Karlovy Vary (Karlsbad).

Many of these springs have been known since the Middle Ages—Karlsbad (Karlovy Vary) is named after Charles IV. who discovered the curative springs in 1347, but it has only recently been found that the mud sometimes accompanying the hot spring water also possesses a healing value when applied externally for such complaints as obesity, rheumatism, etc. This has led to the introduction of mud baths as a regular part of a "cure" at Karlsbad, Marienbad (Marianské Lázne), Bechyne and especially at the Slovak spas such as Piest'any and Trencianské Teplice.

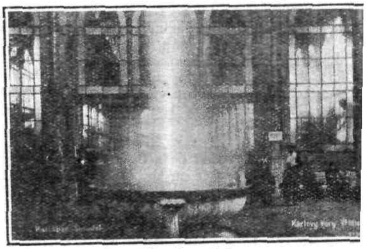
The mud at Trencianské Teplice is ejected with the hot sulphurous water at 42° C. (The name means the hot springs of Trencin) and is sometimes collected for local application to a joint or limb. It is purely inorganic and therefore free from bacteria or other organisms.

When dried at 100-105 C. it has the composition,

Silica	... ...	60.14
Alumina	... ...	13.96
Calcium oxide	... ...	9.61
Iron oxide	... ...	6.10
Sulphate (SO_3)	... ...	3.12
Carbon dioxide	... ...	0.91
Magnesia	... ...	0.89
Potash (K_2O)	... ...	3.46
Soda (Na_2O)	... ...	1.55
Phosphate (P_2O_5)	...	0.001

(see *Chemist and Druggist*, 1928, CVIII, 467).

The curative powers of this and similar muds may be partly due to the fact that they are distinctly radio-active. The sulphur and volatile sulphur content of the water accompanying the mud would also contribute to its efficacy in curing certain diseases.



The Sprudel.

(1) The Waters of Some Czechoslovak Health Resorts, *The Chemical News*, 1927, CXXXV, 169.
Karlsbad Sprudel Salts, *Chemist and Druggist*, 1926, CV, 708; the Karlsbad illustrations are taken from this article.
Slovakian Mud Bath, *ibid.*, 1928, CVIII, 467.
Czechoslovak Thermal Watering Places, *British and Colonial Pharmacist*, 1927, LXXXVIII, 105.
Mud, Sulphur and the Pearl of the Carpathians, *Central European Observer*, 1927, V, 795.

GENERAL NOTES.

MEMORIAL TABLET TO EDUARD SUESS.

The Geological Society of London have issued the following :—

" We are approaching the centenary of the birth of Eduard Suess, for 50 years Professor of Geology in Vienna, author of " Das Antlitz der Erde,' by which monumental work, published between 1885 and 1909, and since translated into English and French, he proved himself to be one of the leading geologists of his time.

Eduard Suess was born in London at 4, Duncan Terrace, Islington, on August 20, 1831, and died in Vienna on April 26, 1914.

Although his study of earth-movements is the work by which he is best known in this country, Suess's researches ranged over a wide field, and, by his teaching in Vienna, he inspired a brilliant school of geologists.

In the city of Vienna a monument is about to be erected to commemorate Suess's service to that city, by his great improvement of its water-supply, and his thirty years' membership of the Austrian Parliament.

The Council of the Geological Society thinks that it would be a fitting tribute to his memory to place on the house in which he was born a tablet recording his great service to British Geology.

The permission of the owner of the house, and of the Local Authorities has been obtained, and it is suggested that any Fellows who wish to contribute to the cost of the Memorial Tablet, which will amount to about ten guineas, should send a small subscription (not exceeding five shillings), to the Secretary.

W. CAMPBELL SMITH *Secretaries.*
J. A. DOUGLAS,
Burlington House,
London, W.1.
June 26, 1928."

EXHIBITION FOR HOUSEWIVES.

COOKING AND HEATING EQUIPMENT FOR MODERN HOMES.

The recent Modern Homes Exhibition, (which was held at Ipswich) by Radiation, Ltd., reveals the remarkable progress made recently in the design of gas appliances.

The Exhibition, which was opened by the Mayor of Ipswich (Major Rowley Elliston), has been arranged to interest local housewives in the new developmnts in domstic gas cooking and heating equipment, and is attracting large numbers of visitors.

The exhibits include cookers and elevated ranges, Injector-Ventilator gas fires designed in a large variety of finishes, water heaters which give adequate service at the lowest possible consumption of gas, geysers, gas-heated radiators, etc.

The gas fires prepared by the six associated firms of Radiation, Ltd., are constructed with the " Injector-Ventilator " which ensures adequate ventilation in the apartments in which they are in use. These fires are made in a wide variety of designs. Many of them are made with an overlaid covering of copper, brass, and pewter, while others are finished in an extensive range of metallic shades. Examples were given to show how they harmonise with the decorative scheme of the rooms in which they are installed.

The exhibits include a large assortment of hot water equipment . Among these are circulating boilers designed to provide a continuous boilers designed to provide a negligible cost. One of these appliances, which is particulary suitable to the needs of smaller homes, has a maximum gas consumption of only 10 cubic feet an hour.

CLEAR SKY PIONEERS.

PAVING THE WAY FOR A HEALTHIER BRITAIN.

In view of the situation arising from the fact that the new Public Health (Smoke Abatement) Act provides no lead for local authorities in dealing with the domestic smoke nuisance, the Urban District Council of Castleford, in Yorkshire, has shown a commendable enterprise in tackling the question.

After investigating the possibilities of various fuels, as a step towards a smokeless and healthier town, the Council tested coalite, the residual fuel of low temperature carbonisation, and it is now using it generally in all departments, including the public baths.

In addition to this practical step, the Council has organised an exhibition demonstrating to the public how this smokeless fuel can be used in household grates and ranges. It has also arranged lectures on the evil effects of air pollution. Local school authorities have been co-operating in this propaganda, and the interest aroused was sufficient to justify postponement of the exhibition's closing date.

This experiment in smoke abatement

educational work will be watched with interest by local authorities throughout the country, who have been reminded recently, by the Ministry of Health, that they are exepected to make full use of the powers at their disposal to eliminate domestic smoke in their area.

FOREIGN EXCHANGES IN JUNE.

Stabilisation of the French franc at a parity of 124.21 to the £ sterling was the feature of the past month. Sterling on New York touched its lowest point since February, but Continental currencies showed little change in relation to the pound.

SHIPPING AT BRITISH PORTS.

As compared with the corresponding month of last year an all-round increase is shown for May in arrivals and clearances of vessels at United Kingdom ports. The advances ranged from 1.5 per cent. in foreign trade departures with cargo to 14.2 per cent. in the similar outward movement of vessels in ballast.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during June, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

Tre total number of applications received during the month was 548, of which 446 were from merchants or importers. To these should be added 12 cases outstanding on the 31 May, making a total for the month of 560. These were dealt with as follows :—

Granted—503 (of which 487 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—39 (of which 33 were dealt with within 7 days of receipt).

Outstanding on 30 June—18.

Of the total of 560 applications received, 520 or 93 per cent., were dealt with within 7 days of receipt.

BRITISH STANDARD CHEMICAL LEAD AND REGULUS METAL.

The British Engineering Standards Association has recently issued the above new British standard specifications.

Copies of the specifications (No. 334-1928 and 335-1928) can be obtained from the British Engineering Standards Association (Publications Department), 28, Victoria

AUSTRIAN LAND REGISTER.

The Foreign Office is informed by the Britisr Chargé d' Affaires at Vienna that a further part of the Vienna Land Register, consisting of 7,420 entries, has been reconstituted.

The High Provincial Court of Vienna has instituted the verification proceedings for this group and has fixed 15 August, 1928, as the closing date of the period within which notification may be made of rights not included in the published Registers and within which objections against rights included in the Registers may be raised. By means of the above three-quarters of the destroyed Land Register have been reconstituted.

A third group, which will probably contain the greater part of what still remains, will be completed in the course of the summer.

USE OF CHLORINE IN THE PREPARATION OF ALUMINA FROM CLAY.

Exceedingly simple, but very efficient seems the process worked out by Dr. T. Susuki and his collaborators of the Rikwagaku-Kenkyujo of Tokyo for the purpose of making pure alumina from clay or allied substances. As in Hall process, the crushed clay is heated in an electric furnace with coke or wood charcoal. The greater part of iron and silicon present in the clay, being reduced, form ferrosilicon, which sinks to the bottom of the furnace and can be tapped off. Alumina floats on the top and can easily be separated from ferrosilicon. This material can not be used directly for the production of aluminium, because of its low grade of purity, smallness of solubility in cryolite and of great hardness of the mass which makes it difficult to crush.

When the lump of thir crude alumina is treated at 200-400° C in current of chlorine gas, iron and silicon present in the mass as impurities combine with chlorine, the chlorides volatilise off and can be collected as the by-products. The mass of alumina thus purified is very pure, can easily be reduced into powdery form and is of soluble nature in cryolite. The following shows an example of the process :

Raw material, Clay, composition : Al_2O_3 51.12 per cent. ; SiO_2 19.14 per cent. ; Fe_2O_3 16.10 per cent.

Crude alumina, impurities :—Fe, calc. as FeO 2.16 per cent. ; Si, calc. as SiO_2 2.80 per cent.

Product of chlorine treatment, impurities :— Fe, calc. as FeO 0.06 per cent. ; Si, calc. as SiO_2 0.02 per cent.

Although possibility of getting alumina of good quality by this process was shown, there are still left for the future such important questions as amount of the consumed electrical energy, cost of chlorine and so forth for the process to be economically successful.—*Journal of the Society of Chemical, Industry, Japan.*

UNIVERSITY COLLEGE (LONDON.)

On July 5 Prince Arthur of Connaught attended the Assembly of Faculties of University College, London, which was held in the Great Hall. He dedicated the table, the chairman's chair, the lectern and the casket, presented by the Old Students of the College, and placed in position the album " Builders of the Great Hall," a volume containing the names of 4,252 members who helped to provide the hall.

Professor Sir John Rose Bradford (Vice-Chairman of the College Committee) presided, in the absence of Lord Chelmsford (the chairman), and presented to Prince Arthur Mr. A. E. Richardson, Professor of Architecture, the designer of the furniture, and Miss Margaret Alexander, by whom the album was designed and executed.

Sir Gregory Foster, the Provost, presenting his annual report, said it would be remembered that in the last week of their centenary celebrations the final stage in the acquisition of the Bloomsbury site for the development of the University was completed. Sir William Beveridge followed up that achievement immediately and set to work to devise the preliminary steps to make the site useful for University purposes. The closing of certain roads that intersected the site had now been sanctioned by Parliament, with the result that a compact area of ten acres was now available for the future development of the University. The ex-Vice-Chancellor was to be highly congratulated on these outstanding results of his period of office. At the request of the President of the Board of Education, the University had decided to enter into relationship with the 22 training colleges in the London area. In place of a mere examination scheme, provision had been made for linking the training colleges in groups to one or other of the colleges of the University. The four men's training colleges, Borough Road, St. Mary's, St. John's, Westminster, were to be associated with this college in an effort to strengthen and improve the training of teachers. The new constitution was expected to take effect early next year. The College Centenary Fund had now reached £207,439. It was hoped that at no distant time the total of £500,000 would be obtained.

The plans for the new University observatory at Mill Hill were ready, and during the long vacation the extension of the Engineering Laboratories would be completed. Next session the college would regain possession of the North Wing of the old University Hall in Gordon Square, and of the Annexe. The plans for the new building for Chemical Engineering were nearly completed and, with the help of the fund raised by Lord Melchett's Committee, building would begin in 1929. The number of students on the college books this session was 3,051, an increase of 81 in regular students.

LOUGHBOROUGH COLLEGE.

Leicestershire, England.

OPEN SCHOLARSHIPS IN ENGINEERING.

The College Governors invite applications for the award of five open scholarships in the Faculty of Engineering, each of the value of £75 per annum. The scholarships are open to British Subjects situate in any part of the Empire, and are tenable at Loughborough College, Leics., England, for the period of the full Diploma Course.

The entrance examination for the Session 1929-30 will take place on Tuesday, Wednesday, and Thursday, the 16, 17 and 18 April, 1929. All applicants must be not less than 16 years of age on the 1 October, 1929.

Candidates resident in the United Kingdom will be required to attend at Loughborough. Candidates resident in other parts of the Empire will be examined on the dates named at Local Centres where recognised facilities are available, and have been approved by the College Governors.

Further particulars and application forms may be obtained from the College Registrar, to whom all forms of application must be returned not later than the 28 of March, 1929.

H. SCHOFIELD, Ph.D.,
B.Sc. Hons. (Lond.).
Principal of the College.

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NOTTINGHAM UNIVERSITY.

H.M. The King, accompanied by Queen Mary, visited Nottingham on July 10 to open the new buildings presented to the University by Sir Jesse Boot.

The beginning of the College may be said to have originated in 1798 when some local Quakers began an Adult School. A Mechanics Institute was founded in 1837 and among the subjects taught was Chemistry. Soon Science and Mathematics obtained complete recognition in the curriculum.

When the Institute was burned down in 1867 mention was first made of the need for a University to serve the East Midland Counties. This hope is now within sight of complete realisation, thanks largely to the continued munificence of Sir Jesse Boot.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

Thursday, June 21.

The following papers were read :—

Solid Dipleidoscope Prisms. By C. V. Boys, F.R.S.

Bloxham's hollow prism, known as Dent's Dipleidoscope, is described. The general problem of the solid dipleidoscope prism is discussed. This instrument affords the best practical means of comparing the intensity of illumination of two images, and can be used to check the accuracy of Fresnel's equations for the intensity of light reflected from and traversing refracting surfaces. It is shown that the solid dipleidoscope prism might be used with advantage to increase the precision of our best astronomical instruments.

Prof. G. I. Taylor, F.R.S., gave an account of the following paper and showed experiments :—

The Forces on a Body Placed in a Curved or Converging Stream of Fluid. By G. I. Taylor, F.R.S..

Expressions are obtained for the forces on a body placed in a curved or conveying stream of fluid. The particular case of straight converging flow is of special interest in Aeronautics. In that case it is found that the resistance is $-(1+\alpha)\,V\delta p/\delta x$, where V is the volume, $\delta p/\delta x$ the gradient of pressure in the fluid, and the "virtual mass" of the body for accelerated motion in the direction of the stream is α times the mass of fluid displaced.

The equations, which are developed on the hypothesis of irrotational motion, are applied to find the couples exerted by curved or converging uow on bodies of various shapes. The couple about the direction of the stream lines is the most interesting, because in a uniform stream of perfect fluid this couple is zero, and even in a real fluid it is zero for all bodies which possess a plane of symmetry containing the direction of the stream. When the stream is curved or converging the asymmetry of the stream reacts with certain elements of asymmetry in the body, causing it to take up certain definite positions. Thus an elongated body with a curved centre line rotates in a curved stream till the plane of the centre line coincides with the plane of curvature of the stream-lines, but the direction of curvature of the body is opposite to that of the stream-lines. This theoretical conclusion is verified in an experiment in which air is sucked by a vacuum cleaner through a curved channel in which a curved body is hung by a silk thread.

Another type of asymmetry is also discussed, and in this case also the theoretical conclusions are verified even more strikingly by experiment.

Erosion by Water-Hammer. By S. S. Cook, F.R.S.

Water, owing to its small degree of compressibility may, under certain conditions, be a powerful agent of erosion. The pressure generated at the first moment of impingement of a column of water at velocity V against a fixed surface without any intervening gas is calculated, *viz.*, $V\sqrt{\rho/\beta}$, this being the pressure instantaneously set up in the front layer of the column. It is independent both of the length and of the sectional area of the column, and therefore it may be inferred that the same pressure will arise from the impact of a drop of water, being in this case, however, confined to the point of impingement, and therefore extremely local. There are, moreover, circumstances which will aggravate the water-hammer by causing large increase of velocity prior to impact. In the case of vacuous cavities collapsing in an incompressible fluid, the work done by the surrounding fluid closing in is converted into velocity energy concentrated, when collapse is nearly complete, at the reduced surface of the cavity; and if further collapse is prevented by the interposition of a fixed surface, high water-hammer pressure will be thus produced.

The erosion of steam turbine blades is

attributed to the impact of drops of water struck by the rotating blades, and it is suggested that this effect may be aggravated by irregularity of shape of the drops, causing a cavity to be entrapped at the surface of impact.

The following papers were read in title only :—

Studies in the Infra-Red Region of the Spectrum. Part I.—Description of Prism Spectrometer and Apparatus. By SIR ROBERT ROBERTSON, F.R.S., AND J. J. FOX.

In this part is given a description of the prism spectrometer and apparatus used to explore the infrared absorption spectrum of the three gases, NH_3, PH_3 and AsH_3. Many difficulties of technique had to be overcome, partly on account of the laboratory being situated near traffic and electric stations, and partly on account of incompleteness (it is thought) in the prescriptions and precautions described in the literature for work in this region. Attention had to be paid to necessity for keeping source of energy constant, for calibrating mechanism for reading wave-lengths, for shielding thermopile from variations of air pressure, for keeping close watch on the temperature of prism, especially when made of rock-salt, on account of the high temperature coefficient of its index of refraction; for accurate alignment of observation tubes, and for obtaining a galvanometer of great sensitiveness and freedom from external perturbations. An account is given of the methods adopted to secure accuracy, and of arrangements which have been found suitable for setting out the apparatus, and housing the various parts. These parts are described under headings : source of radiation, observation tubes and alignment, transference of gas, mercury lamp for calibration, spectrometer, thermopile and galvanometer.

Studies in the Infra-Red Region of the Spectrum. Part II. Calibration of Prism Spectrometer; General Procedure; Preparation of Pure Ammonia, Phosphine and Arsine. By SIR ROBERT ROBERTSON, F.R.S., J. J. FOX, AND E. S. HISCOCKS.

In this part the calibration of the Hilger spectrometer for use with rock-salt, quartz and fluorite prisms is described. The "wave-length drum" was first calibrated in terms of angle of rotation from Paschen's determinations of refractive indices of the three dispersing media, corrected in cases of rock-salt and fluorite to temp. 18° C. by means of temp. coefficients of refractive ndex as given by Liebreich. For the region of the spectrum 0.5 to 16.5 μ, a curve showing the correction, in μ, to be applied to any place on the drum graduation was drawn, and for regions 0.5 to 3.5 μ and 0.5 to 9.5 μ curves were drawn connecting drum graduation and wave-length for quartz and fluorite prisms respectively.

Methods of setting spectrometer and of checking this setting periodically are descrbed. Accounts are given of technique adopted in actual determinations of absorption and of method of calculating results. Preparation and purification by fractional distillation of the gases NH_3, PH_3 and AsH_3 are described.

Studies in the Infra-Red Region of the Spectrum. Part III.—Infra-Red Absorption Spectra of Ammonia, Phosphine and Arsine. By SIR ROBERT ROBERTSON, F.R.S., AND J. J. FOX.

This part contains numerical data obtained. Tables and graphs are given of oscillation and rotation-oscillation bands, together with a general description of bands observed. With the prism instrument used partial resolution was obtained beyond 2.2 μ with quartz, 4 μ with fluorite, and 8 μ with rock-salt. A table is given with numerical values of positions and intensities of maxima of oscillation bands of the three gases. Tables and graphs (on a wave-number basis) give numerical values of the fine structure (rotation maxima).

So far as it has been found possible to identify observed bands as members of sequences, these are indicated in this part, their fuller consideration being reserved for Part IV.

Studies in the Infra-Red Region of the Spectrum. Part IV.—Discussion of Absorption Bands of Ammonia, Phosphine and Arsine. By SIR ROBERT ROBERTSON, F.R.S., AND J. J. FOX.

Types of absorption bands found in the infra-red are described. In certain sequences of bands the members preserve a constant ratio of wave-numbers to one another : 0.68 for PH_3/NH_3 and 0.91 for AsH_3/PH_3. Several harmonic sequences of oscillation bands are found in each gas, but a main sequence is common to all three gases, and a sequence common to NH_3 and AsH_3 alone.

From the bands resolved, the fine structure has been evaluated, and wave-number differences obtained indicating rotation bands. These differences are of the order of 20 for NH_3, 11.5 for PH_3, and 10 W.N. cm^{-1} for AsH_3; but, in addition, a sequence is found in NH_3 having a W.N. difference of 160 W.N. $cm.^{-1}$. The corresponding

moments of inertia for these values are respectively 2.78×10^{-40}, 4.78×10^{-40}, 5.53×10^{-40} and 0.35×10^{-40}. Oscillation frequencies become slower in the order NH_3 to PH_3 to AsH_3, and wave-number differences in rotation bands show that the molecules rotate more slowly in the same order. Intensities of bands are discussed with reference to their relation to Beer's law of absorption. Various molecular models are taken into consideration ,including that of Hund, and support for his view that NH_3 has a tetrahedral structure is adduced from bands observed for the three gases.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, February, 3, 1928.

Sir Almroth E. Wright, K.B.E., C.B., M.D., LL.D., F.R.S., Vice-President, in the chair.

Photosynthesis. By E. C. C. BALY, C.B.E., F.R.S., Professor of Inorganic Chemistry, University of Liverpool.

There is no process within the confines of Chemistry which is of greater interest and importance than that by means of which the living plant prepares the food on which its life and growth depend. This food consists of starch and sugars, together grouped under the general name of carbohydrates, and of certain nitrogen-containing compounds known as proteins. The material from which the plant starts is carbonic acid, or a solution of carbon dioxide, which it obtains from the air, in water which it obtains through its roots from the soil. From this substance alone the plant is able to prepare its supply of carbohydrates, and it is true to say that this chemical process is the fundamental basis of the whole of terrestrial life. This may truly be asserted because the production of the proteins is very closely associated with it and the initial stage is common to the two.

The formation of carbohydrates from carbonic acid when expressed by a chemical equation looks simple enough. There is no doubt that the first product of the process that can be recognised in the plant is a simple sugar, and thus the equation can be written

$$6H_2CO_3 = C_6H_{12}O_6 + 6O_2$$

where the simple carbohydrate is either glucose or fructose. These simple sugars formed to give cane sugar or one of the starches, and these changes can readily be written as simple chemical equations.

The mechanism by means of which the plant achieves the synthesis of these complex compounds from carbonic acid has long been a mystery to chemists and to botanists. It is known that the agency used by the plant to effect its purpose is sunlight, and thus the term photosynthesis has been applied to the operation. It is also known that the plant makes use of certain pigments, such as chlorophyll, and it is to these that the colour of the leaves is due. The mystery of it all lay in the fact that no one knew what actually takes place, and, indeed, the more chemists and botanists explored, the more puzzling did the problem seem to be.

Perhaps the most puzzling fact of all is that the plant only makes use of sunlight, when all our previous knowledge of light reactions leads us to believe that such light is quite incapable of inducing photosynthesis. This may readily be understood if the amount of energy involved in the synthesis is considered. It has been proved experimentally that in order to synthesise one gram molecule (180 grams) of glucose or fructose there must be supplied to the carbonic acid a minimum quantity of energy equal to 673,800 calories. Whilst it is known that the plant manages in some way to absorb the necessary energy in the form of light, the physicist tells us that it cannot directly absorb enough energy from sunlight. Thus the photsynthesis can be brought about by red light of the wavelength $660\mu\mu$ when the energy directly absorbed can only be 260,000 calories, which is far below the minimum quantity required.

The experience gained from the ordinary reactions of photo-chemistry leads to the belief that if it is required to convert carbonic acid into sugars by means of light alone, it will be necessary to use ultraviolet light which is absorbed by carbonic acid, that is to say, light of wave-length $210\mu\mu$. It is obvious from this that some unknown factor is operating in vital photosynthesis.

In any endeavour to elucidate the mystery, it is evident that the first line of enquiry must be to study the action of the short wave ultra-violet light upon carbonic acid. This was first investigated by Moore and Webster in 1913, who found no evidence of any reaction taking place. They found, however, that in the presence of certain catalysts ,such as colloidal iron hydroxide,

produced. Since these results appeared to be at variance with general experience in photochemial investigations, they were again examined some years later in Liverpool, and it was then found that when a stream of carbon dioxide was passed through water irradiated by the light from a quartz mercury lamp, small quantities of formaldehyde were produced. This result seemed to be very satisfactory, since the formaldehyde could be looked upon as an intermediate stage on the way to carbohydrates, especially in view of the fact that Moore and Webster had proved that formaldehyde was converted by light into substance, with properties similar to the simple sugars.

Our observations were criticised by Porter and Ramsperger, who stated that if rigid precautions were taken to guard against the presence of every trace of impurity, no formaldehyde was produced. The suggestion was implied by them that the origin of the formaldehyde was to be found in some unknown impurity. There is, however, an alternative possibility, and one which is more in keeping with the known facts of the natural photosynthesis in the living leaf. There is no doubt that in this reaction the carbonic acid is converted directly into carbohydrates and that formaldehyde as such is not produced, and it seemed that the most probable explanation of the discrepancy between our results and those of Porter and Ramsperger was that the action of the ultra-violet light is to establish a photochemical equilibrium.

$$6H_2CO_3 \rightleftarrows C_6H_{12}O_6 + 6O_2,$$

which reverts to carbonic acid again in the dark. In the presence of oxidisable impurities a small amount of carbohydrates will be formed, which will be photochemically decomposed to formadehyde. This decomposition of all the carbohydrates by means of ultra-violet light is well known.

There is no need to give here the details of the experiments which were carried out to test this view, and it is sufficient to say that conclusive proof was obtained of the reality of the equilibrium : that is to say, carbohydrates were found to be present in the solution during irradiation by ultra-violet light, and these vanished very quickly after the irradiation was stopped.

This gave us at once a starting point, because it seems evident that if a harmless inorganic reducing agent were added to the solution, carbohydrates should be formed in quantity on exposure to the ultra-violet light. Such a reducing agent is ferrous bicarbonate, and great hopes were raised when it was found that a saturated solution of this compound, which was completely colourless when prepared, gave a copious precipitate of ferric oxide on exposure to ultra-violet light. It was evident that the oxidation took place by reason of the oxygen in the carbohydrate equilibrium in accordance with the equation

$$4Fe(HCO_3)_2 + O_2 = 2Fe_2O_3 + 4H_2O + 8CO_2$$

and indeed it was found that on evaporation of the exposed solution a simple sugar was obtained. The quantity produced was very disappointing and far less than was anticipated, and the conclusion was forced upon us that some unknown factor was taking part in the process.

During many unsuccessful endeavours to improve the yield of the carbohydrates, it was noticed that the ferric oxide was not produced in the body of the solution, but only on the walls of the quartz containing vessels and on the surface of the iron rods used to make the bicarbonate. This led us to suspect that the surface was a determining factor, and we at once changed the experimental method so as to increase the surface as much as possible. In order to secure this a suspension of pure aluminium powder in water, maintained by a stream of carbon dioxide, was exposed to ultra-violet light. Increased yields of carbohydrates were at once obtained, but it was also found that the best yields were obtained when the aluminium powder has been allowed to coat itself with hydroxide by remaining in contact with the water before the exposure to light. This latter observation very materially changed our ideas, since it established the fact that the surface phenomenon is of far greater importance than the reducing action, and indeed raised the question as to whether the latter plays any rôle at all in the process.

In order finally to decide this question an aqueous suspension of pure and freshly prepared aluminium hydroxide, maintained by a stream of carbon dioxide, was exposed to ultra-violet light. There was obtained after filtration and evaporation of the solution a quantity of carbohydrates equal in weight to that produced when aluminium powder was used. This conclusively proved the fundamental significance of the rôle played by the surface, and at the same time the reducing action was found to be entirely unnecessary. Identical results were obtained with other powders, such as aluminium, zinc, and magnesium carbonates.

During the course of these experiments it occurred to one of my students (Dr. W. E.

Stephen) that if a green powder were used in place of the white ones the photosynthesis might take place in visible light, the green colour being suggested by the green colour of the plant-pigment chlorophyll. This was found actually to be the case, since a suspension of nickel carbonate maintained by a stream of carbon dioxide in water, on exposure to the light from an ordinary tungsten filament lamp, gave a larger yield of carbohydrates than any of the white powders in ultra-violet light. We soon found that there was no especial virtue in the green colour, and that equally good results were given by pink cobalt carbonate.

Apart from the interest which accrues from the fact that the photosynthesis is thus achieved in a way which shows a real analogy with the natural phenomenon, the method with a coloured surface and visible light has the very material advantage in that the danger of photo-chemical decomposition by ultra-violet light is completely eliminated, with the result that the products are obtained in a purer state.

From the above description of the direct photosynthesis of carbohydrates from carbonic acid in the laboratory several points airse which require discussion and explanation. In the first place it may be stated that the most rigid control experiments which we could devise have definitely established the fact that the carbohydrates are not due to the presence of impurities.

One of the greatest difficulties met with in this work was the preparation of the various materials used for the surfaces, since it is absolutely essential that these be completely free from any trace of alkali. It is well-known that when metallic hydroxides and carbonates are precipitated they tend to absorb the alkali, and the removal of this is extraordinarily troublesome. The absence of any alkaline reaction in the filtrate after the powder has been boiled with water is no criterion of purity, and the only satisfactory method is to pass carbon dioxide into a suspension of the powder in water for two hours in the dark, and the filtrate after concentration must yield no weighable quantity of alkaline carbonate.

It was frequently found that the carbonates of nickel and cobalt, even when completely freed from alkali, were entirely ineffective in promoting protosynthesis. These can, however, be activated either by heating to 120° or by exposure in this layers to ultra-violet light, and this fact afforded a very conyincing method of carrying out controls. A quantity of one of these inactive powders gives no trace of carbohydrates when exposed to visible light in the manner described. The same sample of powder when activated and used in the same apparatus, with the same water, the same light, and carbon dioxide from the same source, gives a good yield of carbohydrates. So, once and for all, is all doubt removed as to the possible effect of impurities.

For the benefit of those who may wish to repeat these experiments, it may be stated that more recently it has been found possible to prepare nickel carbonate by a new method which is free from the objections characteristic of its precipitation by means of alkali carbonate. A solution of carbonic acid in conductivity water is electrolysed, the electrodes being made of nickel plates. The current is taken from a 220 volt circuit, and sufficient resistance is intercalated to reduce the current density to from 1 or 2 amperes per sq. dcm. The electrolyte is cooled by glass coils through which a stream of water is maintained. With electrodes 190 sq. cm. in area it is possible to prepare 30 grms. of pure carbonate in 24 hours. The carbonate should be collected every day by filtration, and it is advisable to clean the electrodes with emery paper every third day.

(To be Continued.)

NOTICES OF BOOKS.

The Works Council. A German Experiment in Industrial Democracy. By C. W. GUILLEBAUD, Fellow of St. John's College, Cambridge. Demy 8vo. Pp. x + 306. Price 16s. net. London: Cambridge University Press, Fetter Lane, E.C.4.

In 1918 there had arisen out of the German Revolution a number of industrial Workers' Councils, a spontaneous product of the revolutionary enthusiasm of a section of German labour. The aim of these bodies was to supersede what they regarded as the bureaucratic and official-ridden organisation of the Trade Unions, by a new type of organisation based solely on the Councils system and imbued with the revolutionary spirit in contrast to the timid reformist socialism of which the Government and the Trade Union leaders were adherents. These Councils were sufficiently powerful to cause a new and vitally important article to be added to the German Constitution by the Constitution Assembly at Weimar. The draft of the Constitution presented by the Government contained no mention of the Councils, but such a storm broke out that on March 5, 1919, the Government gave a

written undertaking that the Workers' Councils should be "recognised in principle as a representation of the workers' interests, and be anchored in the Constitution." A month later the Government issued its proposals for organising and making use of the Councils in the form of an amendment to one of the draft Articles of the Constitution. his amendment, with slight modification, was adopted by the Assembly and included in the Constitution as Article 165, being placed in the group of Articles entitled "Fundamental Rights and Duties of Germans."

The German Constitution was adopted on July 31, 1919, and the Government immediately proceeded, in consultation with employing and labour interests, to prepare a Bill for the establishment of Works Councils. After an enormous amount of controversy this Bill emerged as the Works Councils Act of February 4, 1920—a law which, to those who were the protagonists of the Council or Soviet system ,is a bitter disappointment, a mere shadow of that for which they had hoped, even though to most employers it represents an unwelcome encroachment on their rights and responsibilities as managers of industry and commerce.

In the present volume Mr. Guillebaud traces the origins of the Act and studies its machinery and the subsequent working of the Councils down to 1926.

Die Reflexion von Rontgenstrahlen an Kristallen. By W. H. BRAGG AND W. L. BRAGG. With Foreword by PROF. E. SCHIEBOLD. Pp. xxvi + 148. Leipzig: Leopold Voss. Price 9 marks.

It would appear that the work or Sir William and Prof W. L. Bragg has an especial appeal to continental physicists. Not long ago there appeared (*The Chemical News*, 1927, cxxxv, 366), a review *O povaze Veci*, a Czech translation hy Prof. A. Simek and Dr. H. Simkova, of Sir W. Bragg's *Concerning the Nature of Things* (Bell). Now Prof. Schiebold has collected tbe early (1913-14) monumental papers of these eminent scientists on X-rays and Crystal Structure. The importance of this work may be adequately judged by the fact that 14 years have elapsed since the papers were first published and yet it can be safely stated that their full significance is hardly realised.

Abhandlungen aus dem Gesamtgebiete der Hygiene. By DR. R. GRASSBERGER. Pp. 32. Leipzig and Vienna: Franz Deuticke. 1928. Price 2 marks 40pf., or 3 sch. 40 gr.

The importance of safe domestic water supplies for large towns like Vienna (for which Dr. Grassberger is especially con- both as free gas and combined as bleaching some years now in removing germs and various other low forms of life from water supplies. Dr. Grassberger deals with the technique of these methods and his first volume is of importance to all who are concerned with water analysis.

MR. SEIJI NOMA.

A PERSONAL NOTE.

Mr. Seiji Noma, publisher of nine important Japanese magazines, is an interesting personality. Although he confesses to a knowledge of no western language he has attained to the premier place among Japanese publishers. Beginning life as a schoolmaster he conceived the idea of editing a journal, Yoben (Eloquence), but had great difficulty in finding a publisher. He eventually took over the task himself and has gradually developed his enterprises so that he has magazines catering for all classes. His concern consumes 1,780,000 reams of paper and 890,000 lbs. of ink annually, and it is estimated that his journals have ten million readers.

CORRESPONDENCE.

POEMS BY "OPIFEX."

Sir,

I see that some of the critics are unkind to me; however, that was to be expected since they are literary men and in my poems I have pointed out one or two of their little failings, and of course we none of us like that.

The pharmacists (*Pharmaceutical Journal*, Mar. 17, 1928, vol. cxx, p. 252), are very angry, but they have only themselves to blame for the whole situation.

The Scientific Worker (June, 1928, vol. IV, p. 72), under the *nom de plume* "Phi," shows considerable spleen, as follows:—

"Volumes of verse should surely be reviewed
With pen of tempered steel and ink of gall,
So, to avoid the commonplace or crude,
I think I'll not review this one at all."

His mention of "gall" seems to indicate that it is not so much the literary side of my poems, at which he girds, but at some of their contents.

I should like to reply to "Phi" in the following terms :—

FIE !

Extol mankind and you will earn
His greatest commendation,
A single fault you name will turn
His praise to condemnation.

Opifex.

SAVING LIFE AND TIME.

(*To the Editor of* THE CHEMICAL NEWS.)

Dear Sir,

Why not White Lines for pavements in busy English towns and cities? This has been done in Adelaide, Australia. What a saving of time for hundreds of thousands of pedestrians it would mean. At present I find the only way to get along most town streets, if in a hurry, is to risk my life by walking in the roadway.

An addition advantage is that pedestrians with their backs to adjoining traffic have the warning line and half the footpath to cross before reaching the roadway, thus giving motorists time to avoid them.

Yours faithfully,
H. C. PARRY.

69, Wrawby Street,
Brigg, Lincolnshire.
2 July, 1928.

HYDROCHLORIC ACID.

(*To the Editor of* THE CHEMICAL NEWS.)

Sir,

Can any of your readers tell me if it is possible to get Hydrochloric Acid made up with Vaseline? I require it to put on highly polished glass surfaces before putting them into a dry refrigerator. I am engaged in the manufacture of a particular lens, and in polishing glass a certain quantity of the glass surface, which is removed with rouge, gets, as it were, electrically fused to the polished surface in very minute quantities which cannot be detected with the naked eye. Unfortunately, however, when the work is put in the refrigerator to make the pitch, by which it is fixed to iron tools, contract from the glass, these little particles of glass, with which is a certain amount of rouge, are enlarged, and then appear on the surface of the glass as minute spots or specks, which it is quite impossible to remove in the ordinary way. Rubbing with a 50 per cent. solution of Hydrochloric Acid and water does remove them, but this is a very objectionable method, "sleeking the glass" being constantly set up. It has been contended by some people, Sir Herbert Jackson, I believe, among others, that these particles of glass and rouge, which appear on the surfaces, are due to what is known in the trade as "hot polishing," but I myself am satisfied, from experiments I have made, that *wet polishing* does not overcome the difficulty. I find that when taking the blocks of work and rubbing the polished glass very thickly with ordinary vaseline, this very greatly reduces the bad effect of the refrigerator on the surfaces of the glass, but nevertheless there is sufficient damage caused to make it essential to find some more effective remedy if possible. I should, of course, be quite willing to pay a fee for any research in the matter, provided I knew beforehand in what sum I was likely to be involved. I venture to write to you because some years ago the *Chemical News* was able to help a friend of mine, who is engaged in the same trade.

Yours faithfully,
L. MARSDEN.

126, Broadwater Road,
Welwyn Garden City,
Herts.
July 3, 1928.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

18,009.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of highly concentrated nitric acid. June 21st.

18,051.—Polanyi, M.—Synthesis of chemical substances. June 21st.

17,649.—Warburton, T.—Production of acid sulphate of alphanaphthylamine. June 19th.

17,973.—Wiese, H.—Purification of saccharine liquids. June 21st.

18,208.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of 4-amino-1-oxybenzene, etc. June 23rd.

Specifications Published.

275,590.—Binz, Dr. A., and Rath, Dr. C. Production of nitropyridine arsinic acids.

292,186.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of sulphuretted hydrogen or sulphides from sulphur.

264,585.—I. G. Farbenindustrie Akt.-Ges. Concentration and distillation of solutions of hydrogen peroxide.

264,530.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of carbazole quinones.

Abstract Published.

289,841.—Sulphoacids. — Oranienburger Chemische Fabrik Akt.-Ges., 1a, Hardenbergstrasse, Sharlottenburg, Berlin.

Halogensubstituted sulphoacids. — Halogen carriers are used in the production of halogen-substituted sulphoacids by treating aliphatic, aromatic or hydroaromatic compounds or mixtures thereof with sulphuric acid halohydrins. In examples, castor oil and a mixture of ground nut fatty acid, wool-fat and benzene are treated with chlorsulphonic acid with the addition of pulverised pyrolusite and the products neutralised. Carboxylic acids, fatty substances, mineral oils, alcohols and lactones are specified as suitable substances which may be treated according to the invention. Specifications 283,864 and 288,126 are referred to.

The Latest TRADE MARKS

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487,568.—Chemical substances prepared for use in medicine and pharmacy.—Carton Syndicate, Limited, 34 and 36, Gresham Street, London, E.C.2. June 27th.

VAPURA.

486,193.—Chemical substances prepared for use in medicine and pharmacy.—Thomas Kerfoot & Co., Limited, Bardsley Vale Mills, Oldham Road, Bardsley, Lancashire. June 27th.

NEOSTIBOSAN.

491,346.—Chemical substances prepared for use in medicine and pharmacy.—Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. June 27th.

CRAIPHOS.

490,349.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes. — Patullo, Higgs & Co., Limited, High Street, Orpington, Kent. June 27th.

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GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.

The Treasury have made an order under Section 10 (5) of the Fnance Act, 1926, exempting Vanadium-silica compounds specially prepared for use as catalysts for sulphuric acid manufacture from Key Industry duty from 9th July, to 31st December, 1928.

The Treasury Order will shortly be published by the Stationery Office.

IMPERIAL CHEMICAL INDUSTRIES ACQUIRING INTEREST IN NOVA SCOTIA SALT MINES.

Report says that a substantial interest in the Malagash Salt Company Ltd., has been acquired by Imperial Chemical Industries Ltd. The journal in question states that Imperial Chemical Industries are understood to have retained Dr. Hayes, a noted New Jersey geologist, to go to Malagash in order to ascertain the extent of the present development, with attention to the possibilities of recovering potash which is found associated with the rock salt deposits underlying the Malagash Peninsula.

FURTHER METRICAL CHARACTERISTICS OF THE SOLAR SYSTEM.

By F. H. LORING.

In the *Chemical News* of April 13, 1928 (CXXXVI, 225) certain metrical characteristics of the planets were developed and the equation for the B numbers given. In the same Journal of May 4, 1928 (CXXXVI, 276) further metrical relations were shown. All these relations appear to have a common B-number basis. From this development the planets can be symmetrically arranged so that a sort of periodic table of them can be drawn up. This possibility was briefly outlined in the former article (p. 228). In this Journal of June 22, 1928 (CXXXVI, 387), this was shown in detail.

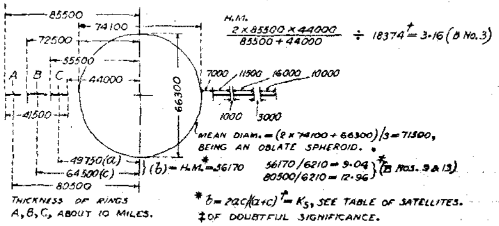
In order to complete the metrical relationships the accompanying tables and diagrams are given.

Table I is inherently explanatory and it is only necessary to indicate that the dividing constant, K., is 18374. The value 411 is approximate and it is slightly lower than the arithmetical mean of the two values 387.2 and 437.2. M = mean distance from

TABLE I.

Satellite.	M.	M/K_5	B No.	Diff.
		EARTH		
Moon	238 857	13.00	13	0.00
		NEPTUNE		
Nameless	219 800	11.96	13	+1.04
		URANUS		
Ariel	119 100	6.48	7	+0.52
Umbriel	165 900	9.03	9	−0.03
Titania	272 200	14.81	13	−1.81
Oberon	364 000	19.81	21	+1.19
		50.13	50	
		SATURN		
Rings	..		3	
Mimas	115 300	6.87 } ....7.05......		
Enceladus	147 800	8.04 }	7	−0.05
Tethys	183 000	9.96	9	−0.95
Dione	234 400	12.76	13	+0.24
Rhea	327 300	17.81	21	+3.19
Titan	758 800	41.29 } ...45.25....		
Hyperion	919 700	50.05 }	45	−0.25
Iapetus	2 210 000	120.28	119	−1.28
Phœbe*	8 034 000	437.2	411	—
		JUPITER		
Fifth	112 600	6.13	7	+0.87
—	—	—	9	—
Io	261 800	14.24	13	−1.24
Europa	416 600	22.67	21	−1.67
Ganymede	664 200	36.148 } ..46.1		
Callisto	1 168 700	63.606 }	45	−1.10
—	—	—	119	—
Sixth	7 114 000	387.2 } ...392.0		
Seventh	7 292 000	396.8 }	411	—
Eighth*	14 600 000	794.6 }		
Ninth*	15 000 000	816.4 }	805	—

FIG. 1.



Referring to Fig. 1, the metrical characteristics of Saturn are shown, the values representing miles, as taken from a description of Saturn's rings given in "Astronomy," vol. I., p. 885.

The equation given on page 227 (*loc. cit.*) sets the limit of the true B numbers at 119. This would seem to suggest that Saturn and Uranus were separated by some catastrophe, such as an explosion, so that the harmonic mean has to be taken, and that Neptune was a thrown-out product either from one of these two planets or from Jupiter which is relatively a very massive planet, as is well known.

Similarly, in the case of the satellite Titan, which is a massive satellite paralleling numerically with Jupiter (45), it had thrown out Phœbe, or, as an alternative, see the diagram; while, in a precisely similar

manner, a satellite at a distance represented by the B number 119, viz.: 119 × 18874, exploded and gave rise to the very small satellites beyond Callisto, *i.e.*, the 6th, 7th, 8th and 9th. The planets with an asterisk are those known to be retrograde in their motion. This line of reasoning will be better understood by referring to Fig. 2, X being the at-one-time satellite which exploded. There may have been more than one explosion, however, so that the phenomenon may have occurred in successive stages.

Reference has been given to the approximate evaluation of the planetary periods in this Journal (p. 228). Table II, with a superposed curve shows this calculation. The higher values are only approximately evaluated according to the tentative scheme. The object of the curve is merely to show that the extreme values would fit into, or form, a smooth curve as drawn; but obviously the curve might be quite different and still accommodate satisfactorily the values in question when considerably modified.

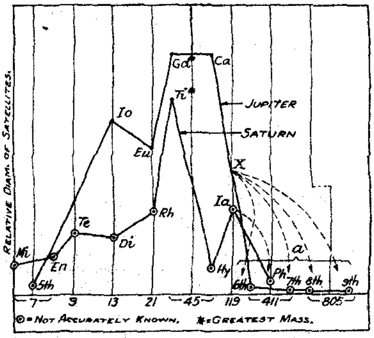
It should be noted that in the tables and one diagram the bracket (}) indicates that a harmonic mean is taken.

The thrown-out satellites from other satellites may in one sense be regarded as re-captured satellites, in so far as they are retained by the primary; and, therefore, to expect close agreements with the numbers 411 and 805 is not reasonable. The *true* B-number series is therefore : 3, 7, 9, 13, 21, 45, 119, as the equation indicates, and these numbers are derivable from the atomic numbers of the inert gases without error, as previously indicated (p. 227).

It will be obvious that the explosive idea herein developed (see also the previous articles) may be extended and thus seemingly account for the bracketted values throughout Table I.

Apart from the at-one-time '119' satellite of Jupiter, which, as stated above, may have exploded, there is according to Table I a missing satellite having a mean distance from its primary of 9 × 18874 miles, but the agreements on the whole are better than those of the Titius-Bode rule which is limited to the planets. This well-known rule shows considerable error at Neptune, and the series is mathematically irregular at Mercury. Ignoring these two detrimental features the net difference by the so-called Bode law is about +9.3, which is considerably greater than when using B numbers. The net difference up to and including 119 is for the satellites appreciably *less* (see Table I) being −1.83.

FIG. 2.



With regard to the satellites of Mars, these may be captured asteroids as H. Jeffreys has poined out his book, "*The Earth,*" 1924, p.60.

The use of B numbers shows a wide range of agreement and these numbers seem to have a basis in the periodic classification of the chemical elements, thus linking the atom up with the solar system.

It should be noted that in using the word *explosive* the phenomenon so implied may not necessarily be always self-contained, for outside influences may have been operative, involving tidal action. Moreover, the time involved may have been greater than that usually associated with explosions. In the

It is not easy at this date to discover why Lawes and Gilbert began the system of continuous cropping, but before it had gone on very long its advantages became manifest, and Gilbert wisely kept the system going all his life. Lawes himself would have ended the experiments in 1893; indeed, it is asserted by the older workers at Rothamsted that he actually gave the order to break up the plots and turn the land back to ordinary farming, but was dissuaded by Gilbert, who thus saved the plots. By that time they had become classical; and from then onwards no director has been prepared to take the risk of making any change, so that they go on as of old, and they are now by far the oldest experimental plots in the world.

Sir A. D. Hall, when director, surveyed the whole of the results and published his summary and conclusions in the "Book of the Rothamsted Experiments" in 1905. This appealed so much to agriculturists that the edition was soon exhausted, and a second edition called for. Up to this point the purpose of the investigations had been mainly to discover how much fertilisers would increase the growth of crops, and what quantity of fertiliser would give the best results. Liebig had stated that the increased yield should be proportional to the quantity of fertiliser added, so long as this supplied the nutrient present only in minimal amounts in the soil. Lawes and Gilbert showed that this was not quite true for nitrogen compounds, there being a point beyond which the increases in yields fell off—an illustration of the law of diminishing returns. For the wheat crop this was reached when 4 cwt. sulphate of ammonia per acre was applied, along with an adequate dressing of superphosphate and potassic fertilisers : the dressings amounted to 10 or 11 cwt. per acre all told. This result has been somewhat misunderstood, and has been used to argue that high farming is no cure for agricultural depression. The quantity of fertiliser used is, however, so great that the result affords no guidance whatsoever to the man who simply wishes to know whether he should use 1 cwt. of sulphate of ammonia or 2 cwt. per acre, and whether he should add superphosphate or not.

The Statistical Analysis of Field Experiments.

After Sir Daniel left, the present director recognised the impossibility of coping adequately with the enormous mass of data by the older methods of averaging and inspection. He therefore set up a Statistical Department under Dr. F. A. Fisher, whose function was the examination of the whole of the field results. Simultaneously, efforts were made to improve the accuracy and reliability of the field experiments. In the old experiments of Lawes and Gilbert a considerable degree of accuracy was obtained, but the probable error could not be *calculated*, so that the *significance* of the results could not be assessed numerically. One great advantage of continuing the experiments for many years was that after some sixty years enough material had accumulated for study by the new statistical methods which Dr. Fisher devised for dealing with small "samples," as distinct from the older methods, which required very considerably larger numbers. For the many points that required further examination in the field, however, it was impossible to presuppose a fifty years' continuance of the experiment, and therefore the new methods were designed to give results of *known significance in* one year. The new methods are based on two essential requirements : the treatments must be replicated, *i.e.*, there must be several plots under each treatment, each plot being regarded as separate and distinct, and the plots must be set out in random order and not according to any bias; the arrangement is determined by the random drawing of cards on which the different treatments have been written. The results thus obtained have statistical value because their probable significance is known; they therefore constitute good data in seeking correlations between crop yields and weather or soil conditions.

With these new methods a new subject has been opened up for investigation—the study of the influence of nutrients on the reaction of the plant to environmental conditions; in other words, the effect of soil and climatic conditions on the effectiveness of fertilisers. This subject is now being steadily developed at Rothamsted. Its practical importance lies in the uncertainty hitherto attaching to the action of fertilisers; farmers were advised that the fertiliser would probably be useful, but much would depend on the soil and the vagaries of the season, and so that was always a considerable and uncalculable element of chance. The purpose of the new work is to reduce these variations to order. The results show that nitrogenous fertilisers are more steady in their action than either phosphates or potassium salts.

Over a series of years, 1 cwt. of sulphate of ammonia per acre gives an additional 20

cwt. of potatoes, 5 bushels of wheat, 6 of barley, 7 or 8 of oats, with but little variation from year to year. There is, however, one important exception. When a crop is sown late, the expected increase in yield may not be obtained; indeed, in extreme cases, there may even be a decrease in the amount of grain. Potassic fertilisers and phosphates, on the other hand, show marked difference in effectiveness from season to season, being specially valuable in certain weather conditions: a property of great value as it holds out the hope of enabling farmers to mitigate the effects of bad seasons.

The investigations indicate the possibility that, if the general character of a season could be predicted, appropriate manurial schemes could be drawn up for mitigating its bad features and utilising to the fullest extent all its good ones. Alternatively it would be possible to construct Tables of Expectancy of Crop Yield, on the basis of which large fertiliser combines could insure farmers using recognised fertiliser mixtures against getting less than an agreed yield per acre.

In the meantime, four important lines of investigation are being followed up:—

(1) The effect of seasonal conditions on the effectiveness of fertilisers.

(2) The relation between the quantity of fertiliser and the yield of crop.

(3) The effect of variations in time of application of the fertiliser.

(4) The influence of the fertiliser on the composition of the crop.

The scope of this paper is confined to nitrogeneous fertilisers; important results are, however, being obtained for phosphatic and potassic fertilisers also. Dr. Fisher has shown that the effect of season on yield of wheat and barley—he has studied particularly rainfall and sunshine—depends on the fertiliser scheme, and he has obtained curves which put this complex problem into a form in which it can be studied by plant physiologists.

The older experiments of Lawes and Gilbert, on the relation of amount of fertiliser and crop yield, were made with large quantities of ammonium salts per acre, the steps being approximately 0, 2 cwt., 6cwt., sulphate of ammonia per acre. For practical guidance the steps are too wide; the chief interest attaches to quantities below 2 cwt. per acre. It being dangerous to extrapolate, there is no means of deducing from the results the effects of ½ cwt., 1 cwt., or 1½ cwt. sulphate of ammonia per acre, yet these are the quantities about which farmers ask information. Some twenty years ago, Mitscherlich put forward a modification of Liebig's hypothesis which gave a logarithmic curve in place of Leibig's straight line.

This implies that the largest increments in yield are given by the smallest dressings of fertiliser ;these, therefore, are relatively the most profitable. The recent field experiments at Rothamsted, however, show that this is not true; numerous instances are found where the second dose of fertiliser gives a larger increment in yield than the first; the cuurve is not logarithmic, but has an inflexion like the curve for the velocity of an autocatalytic reaction. The practical deduction is that it is more profitablt to fertilise a crop adequately than inadequately. *Assuming the crop is to be grown it is more likely to yield a profit if* properly fertilised. It becomes necessary, therefore, to determine for the various crops the optimum range of fertiliser effectiveness. This is steadily being done for the more important crops. The position of the inflexion, and therefore the optimum range, varies with the character of the season; for potatoes it varies from 2 to 4 cwt. of sulphate of ammonia per acre, usuing also suitable amounts of phosphate and potassium salts.

(To be Continued.)

GENERAL NOTES.

ALBERTA BITUMINOUS SANDS FOR PAVING PURPOSES.

By S. C. Ells,

Mines Branch, Department of Mines, Ottawa.

In various publications issued in recent years by the Mines Branch, Department of Mines, Ottawa, reference is made to an extensive deposit of bituminous of asphaltic sand situated in the vicinity of Fort McMurray in Northern Alberta. Departmental activity in connection with the investigation of this deposit has included field explorations, laboratory sturies and practical working demonstrations.

Bituminous sand pavements were first laid in Edmonton in 1915 under the supervision of the Mines Branch and these demonstration surfaces remain in good condition. In 1926 Alberta bituminous sand was used for the first time on a commercial scale for the surfacing of highways, when

upwards of 5,000 square yards of pavement was laid at Jasper, Alberta, and in 1927 further surfacing amounting to approximately 30,000 square yards was undertaken at Jasper, comprising the use of standard mixtures for highway surfacing, parking areas, and footpaths. This work involved the designing and constructing of a suitable heating and mixing plant consisting of two internally heated drums, similar to the equipment commonly used in the mixing of Portland cement concrete.

As a result of this work it is apparent that as settlement advances in the region surrounding these deposits and transportation costs decrease, the utilisation of Alberta bituminous sand for road surfacing on a commercial scale should present interesting possibilities for capital. Other conditions being equal, the cost of the finished wearing surface should be materially less than when oil asphalt (petroleum residum) mixtures are used. Should a satisfactory process be developed for the separation of bitumen from bituminous sand, a drum type mixing plant similar to that used at Jasper could, with minor alterations, be adapted to the manipulation of synthetic mixtures. Conditions within the petroleum industry during the past two years have not been such as to stimulate research into the recovery of hydrocarbons from the crude bituminous sand, but the problem is receiving attention in various quarters.

THE INSTITUTE OF METALS.

Meeting in Germany.

The Council of the Institute of Metals has accepted a very cordial invitation from the Verein Deutsche Ingenieure and the Deutsche Gesellschaft für Metallkunde to hold next year's autumn meeting of the Institute in Germany. The meeting will take place in Düsseldorf. It is expected to prove very attractive not only to British members but also to members resident in Continental countries, who number many hundreds. The latter often find it difficult to attend meetings in the British Isles but—as was proved on the occasion of the Institute's gatherings held in Ghent and Liége—they come freely to meetings held on the Continent. Düsseldorf is so readily accessible, and so full of metallurgical interest that the meeting in that city—the first to be held in Germany by the Institute of Metals—is certain to be well attended and successful, supported as it will be by powerful German technical societies and by a large and enthusiastic German membership.

MALAYAN IMPORTS OF CHEMICALS.

The imports of chemicals into Malaya during January-February totalled £328,322, as compared with £368,766 during the corresponding period of 1927.

CANADA'S TEN THOUSAND MINERAL INDUSTRIES.

According to a preliminary report just issued by the Dominion Bureau of Statistics at Ottawa, there were in operation in Canada in 1927, no less than 10,256 metal mines, metallurgical works, coal mines, oil and gas wells, other non-metallic mines and quarries, cement plants, lime kilns, brick and tile plants and sand and gravel pits.

Capital employed in these industries, represented by the cost of properties and plant as well as liquid assets, reached a total of $706,602,942, an increase during the year of $17,850,000. Employees numbered 82,530; salaries and wages totalled $103,482,019; and the net value of sales from these various mining and metallurgical industries was $248,385,031 or 4.6 per cent. more than in 1926.

Capital employed in the 1,558 plants included in the metal-mining industry totalled $382,820,985. Metal-mining and non-ferrous metallurgical industries employed 25,985 people throughout the year and provided $40,400,790 in salaries and wages. Sales from non-ferrous metallurgical plants less estimated cost of ores treated realised $45,479,578.

ENQUIRY INTO QUALIFICATIONS PRESCRIBED FOR MINES OFFICIALS.

The Secretary for Mines annunces that he has now set up the Committee of Enquiry into the examinations and qualifications prescribed or Officials of Mines under the Coal Mines Acts under the chairmanship of Sir Thomas Holland, the proposed appointment of which was referred to in the House of Commons on 21 June.

In addition to the gentlemen who had at that time consented to serve on the Committee, Mr. Mungo Mackay, Mining Engineer, of the Lothian Coal Company, has been appointed a member.

The Secretary of Committee is Mr. A. M. Clegg, M.B.E., of the Mines Department, to whom all communications on the subject of the Committee's Enquiry should be addressed at Dean Stanley Street, Millbank, London, S.W.1.

MOTOR VEHICLES REGISTERED IN BRAZIL.

The British Consul at Sao Paulo reports that according to statistics published by the Federal Ministry of Agriculture, the total number of automobiles in Brazil in 1926 was 58,175 as compared with 42,743 in 1925 and 25,887 in 1923.

EXPANSION OF THE ACCOUNTANCY PROFESSION.

With the election to membership of the 128 candidates who have recently passed the Final Examination, the Membership of the Society of Incorporated Accountants will easily pass the 5,000 mark, which figure represents, despite the War and the maintenance of a high standard of professional experience and examination, a one hundred per cent. increase in Membership during the past sixteen years. The expansion of the profession during the last quarter of a century has been largely due to the growth of the Joint Stock Company and the extension of the incidence of taxation.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

June 21, 1928.

The following papers were read :—

The Photo-Electric Properties of Some Metals in the Soft X-ray Region. By L. P. Davies. Communicated by O. W. Richardson, F.R.S.

In order to test whether the soft X-ray efficiencies found by Richardson and Robertson are dependent to any great extent on the substances forming the photo-electric detector, a tube of similar design to that used by Richardson and Robertson is fitted with four different substances in turn as photo-electric plates. These substances are iron, cobalt, copper and nickel, and these four metals also form the anticathode. From the results it appears that the ratios of the soft X-ray efficiencies are not affected by changing the photo-electric plate, but that their absolute values are. Approximately, iron and nickel are 10 per cent. more efficient than cobalt and copper as soft X-ray emitters, and 20 per cent. more efficient than cobalt and copper as photo-

Condensation Phenomena at Different Temperatures. By C. F. Powell. Communicated by C. T. R. Wilson, F.R.S.

An apparatus is described whereby the supersaturation required to produce condensation on ions and on associated molecules in the presence of dust-free air, over a range of temperature from −25° to 50° C., has been measured.

The effect of the air on the phenomena has been investigated, and it has been shown to be of importance not only by determining the amount of water vapour condensed/unit volume for a given degree of supersaturation, but also by preventing the evaporation of water from the walls of the expansion chamber.

By an extrapolation the supersaturation necessary to produce cloudy condensation at temperatures up to critical point has been estimated, and the state of steam at the cloud limit at different temperatures calculated.

It is shown that, apart from the experimental difficulties to be met in working at higher temperatures, atmospheric temperature gives the best conditions for the cloud method of investigating atomic phenomena.

The Selective Photo-chemical Action of Polarised Light.—Part III. By E. S. Semmens. Communicated by E. C. C. Baly, F.R.S.

Well-washed potato starch grains, in distilled water, are shown to disintegrate under the influence of a Tyndall beam of light, polarised by the colloidal particles of diastase, contained in an outer vessel.

The stages of hydrolysis are recorded, and the products, as photographed, are seen to bear a strong resemblance to those formed under ordinary diastatic action.

These results suggest that the polarisation of the incident radiation of heat or light is an important factor in the action of colloidal catalysts.

As catalytic action takes place at surfaces, the possibility of some correlation between the constant plane of vibration of the radiation and the definitely orientated force fields or electron orbits of the molecular surface layers is indicated.

The Absorption Spectra of Solutions of Cobalt Chloride, Cobalt Bromide and Cobalt Iodide in Concentrated Hydrochloric, Hydrobromic and Hydriodic Acids. By W. R. Brode and R. A. Morton. Communicated by E. C. C. Baly, F.R.S.

In a previous paper the principal absorption band of cobalt chloride in concentrated

hydrochloric acid was shown to consist of six super-imposed component bands. The frequencies of the maxima of these bands also occur in the blue and green regions. *Frequencies of the maxima of absorption curve* are always, within the limits of error, integral multiples of 12.28 f. The absorption curve of cobalt bromide in concentrated hydrobromic acid likewise consists of a number of component bands. If chloride and bromide systems are compared, corresponding bands are given by use of same intergers, but with fundamental frequencies of 12.28 and 11.70 respectively. Cobalt iodide in hydriodic acid also shows banded absorption which can be resolved into six components, the frequencies of maximum absorption being integral multiples of a fundamental frequency which is now 10.79 f.

The Mechanism of Chemical Change. I.—Promotion and Arrest of the Mutarotation of Tetra-Acetylglucose and Ethyl Acetate. By T. M. Lowry, F.R.S., and G. G. Owen.

By making use of an ignited silica flask, solutions of tetra-acetylglucose in dry ethyl acetate have been prepared which were sufficiently pure to show no change of rotatory power during a period of several hours. The addition of a drop of water to such a solution does not suffice to initiate mutarotation, but a rapid change is induced when a drop of dilute acid or alkali is added; the mutarotation curves are, however, inflected instead of unimolecular, as if the action had been resolved into two consecutive stages.

Since the action of alkali was the same when the polarimeter tube was rinsed with the solvent and refilled with a second sample of the clean dry solution, it appears possible that these inflected mutarotation curves are characteristic of surface action, whereas the normal unimolecular curves are developed by homogeneous catalysis.

The Homogeneous Reaction Between Hydrogen and Oxygen. By C. H. Gibson and C. N. Hinshelwood. Communicated by Sir Harold Hartley, F.R.S.

In continuation of a previous investigation, the combination of hydrogen and oxygen at temperatures between 500° and 600° C. has been studied by a static method, the reaction vessels being of porcelain instead of silica as before.

It is confirmed that above 500° a homogeneons reaction comes into play. The order is high and somewhat variable; the temperature coefficient is high, and the reaction at higher temperatures is retarded gases. The rate is approximately proportional to the cube of the hydrogen concentration and to a power of the oxygen concentration which is greater than unity.

The reaction is very markedly accelerated by steam, but also by gases such as helium, nitrogen and argon. Thus the action of steam is not necessarly autocatalytic in the ordinary sense.

The results can be interpreted by assuming reaction chains propagated through the gas. These chains are broken by de-activation of molecules in a heterogeneous reaction at the walls of the vessel, and lengthened by presence of inert gases, which increase the time during which molecules escape contact with walls. The order of effectiveness of various inert gases can be correlated with diffusion coefficients.

The Characteristics of a Karman Vortex Street in a Channel of Finite Breadth. By H. Glauert. Communicated by G. I. Taylor, F.R.S.

The theory of the drag due to the formation of a vortex street behind a body has been developed by Karman, and an attempt has now been made to extend the analysis to the case of flow in a channel of finite breadth, but for simplicity the analysis is confined to the case when the breadth of the vortex street is not more than one-sixth of the breadth of the channel. The formula obtained for the drag of the body is similar to that given by Karman and involves two parameters which must be determined experimentally.

By means of certain assumptions the analysis has been developed to a further stage, which makes it possible to predict the constraint of the channel walls in terms of the flow in an unlimited fluid. The final equations so obtained lead to values in good agreement with experimental results in the case of a flat plate, but it appears that the assumptions on which the analysis is based are valid for bodies of bluff form only and break down for bodies of elongated shape.

On Series in the Spark Spectra of Germanium. By K. R. Rao and A. L. Narayan. Communicated by Lord Rayleigh, F.R.S.

The spark spectra of germanium have been analysed. To aid in the identification of the important groups of different stages of ionisation the spark spectrum of the element under different conditions of excitation has been photographed from λ 6,500—λ 2,080, and measured with an accuracy of about 0.05 A.U. About 80 lines of ger-

Ge II.—This spectrum has been almost completely analysed, and the doublet system is found to be in entire accord with that predicted from Hund's theory. The first and second doublet P separations are 1764 and 860 respectively. The largest term 1 $^2P_1$, equal to 128635, yields an ionisation potential of about 15.88 volts. The resonance potential is 7.70 volts.

Ge III.—Series of sharp and diffuse triplets have been detected, converging to a common limit. The fundamental multiplet is also recorded. These have led to the identification of the members of the primary series with certainty. The resonance line has been suggested and the probable ionisation potential is estimated to be 33.17 volts. The chief ^3P intervals are 1642, 768.

Ge IV.—Series in this spectrum have been extended to the region of long wavelengths, members of the secondary series being found.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, February, 3, 1928.

Sir Almroth E. Wright, K.B.E., C.B., M.D., LL.D., F.R.S., Vice-President, in the chair.

(*Continued from page 29.*)

To sum up the results, so far as they have been described, it has been found possible in the laboratory to produce carbohydrates directly from carbonic acid by a process which is physically similar to that of the living plant. The essential difficulty in our understanding of the natural photosynthesis has been solved, namely the use of visible light as the agent in a process which the elementary laws of photochemistry taught is to believe could only be achieved by means of ultra-violet light. As so often happens the explanation when found is very simple. The great amount of energy required to convert the carbonic acid into carbohydrates is supplied to it in two portions, one by the surface and the other by the visible light.

Nothing has as yet been said of the actual carbohydrates which have been photosynthesised in the laboratory. Although as yet our information is still meagre, there is no doubt that the photosynthetic syrup is a mixture containing glucose or fructose, or both. There are also present more complex carbohydrates, which can be resolved to the simple sugars by the action of dilute acid. The analogy with the products of natural photosynthesis is too close to be passed by without comment.

Although it has not as yet been possible to carry out a complete analysis of this syrup, owing to the difficulty of preparing a sufficiently large amount, interesting information has been gained from the investigation of the sugar syrup obtained by the action of light upon formaldehyde solution. his has been pursued during the last three years. We owe a debt of gratitude to Sir James Irvine for the signal help he has given us in this work. He himself was the first, in association with Dr. Francis, to prove that glucose is one of the substances actually produced. By oxidation of the sugars to the acids by means of bromine, and the crystallisation of the salts of these with brucine, cinchonine and quinine, we have obtained d-gluconic and also d-erythronic acids. This not only confirms Irvine and Francis in their proof of glucose, but it also proves that fructose is formed just as in the living plant. In addition to that, there is produced a mixture of complex acids which afford convincing evidence of the synthesis of complex carbohydrates.

Although it may be thought that the use of formaldehyde as the starting point takes away something from the interest, yet it must be remembered that it makes but little difference whether in actual fact we start from carbonic acid or formaldehyde. Without doubt the first substance, transiently formed in either case, is the same, namely, activated formaldehyde which polymerises to the sugars.

The similarity between the vital and the laboratory processes is not confined to the fact that the products from the two are the same. Botanists tells us that in the living plant the photosynthesis takes place on a surface, so also is a surface necessary in the laboratory. It has been found possible to compare the quantities of carbohydrates synthesised for equal areas exposed to light in the case of living leaves and the glass vessels of the laboratory. These quantities are about the same. Some plants produce more and others produce less than we are able to synthesise. This similarity may be emphasised, because surely Dame Nature in the living leaf has produced the best machine she could for her purpose of food production for her children in the vegetable kingdom.

There is yet another striking feature which is common to the two(photosynthesis *in vivo* and *in vitro*.) The light must not be

too strong in either, for if it is too strong *then harmful results at once supervene.* This is due to the poisoning of the surface by the oxygen which is set free. In both cases this poisoning slowly rights itself, and in both the synthesis must not proceed at a greater rate than that of the recovery of the surface from its poisoning.

In fine, so far as we have been able to carry the investigations, the processes in the living plant and in the laboratory show most striking resemblance, not only in the compounds which are formed, but in every feature which is characteristic of either of them.

For my own part I would go further than this, because I believe that these experimental results help us to gain some understanding of the chemistry of life, the chemistry which is so different from that of man's achievements with his test tube, flask and beaker. Within the confines of vital chemistry reactions take place which are so far outside our own experimental experience that it came to be believed by many that they were under the control of a mysterious force, to which the name of *vis vitalis* was given. One of these processes has come within our purview to-night, the condensation of the simple sugars, glucose and fructose, to form can sugar, starch and insulin. No one has yet succeeded in effecting these syntheses in his laboratory, but it would seem that something of that nature takes place in our photosynthesis. Why then is it that even this step forward has been gained?

The one lesson that we have gained from photosynthesis is, that the definitive factor is the very large amount of energy which must be supplied to the carbonic acid before the synthesis of the simple sugars takes place. The means of supplying that energy do not concern the argument. The synthesis proceeds at an energy level which is far higher than is the case in the reactions of ordinary chemistry, and the sugars are formed at that high level. I myself believe that the condensation reactions to give the more complex carbohydrates are those which are characteristic of the simple sugars when they exist at the high energy-level. The reason why no one has succeeded up till now in inducing these reactions to take place is because no one has hitherto been able to supply the large energy increment necessary.

I myself believe that we find in this the key which unlocks the door of vital chemistry, and that the chemistry of all life is one of high energy, our laboratory experience being confined to the chemistry of low energy. From this view point I see a wondrous vista unfold itself, wherein new understanding, new hopes and new possibilities reveal themselves. Health and vitality must essentially depend on the high energy level being maintained; any lowering of that level will lead to poor health and weak vitality. Knowledge comes to us of the means whereby the high level may be kept unimpaired. The most important sources from which we can absorb high energy are fresh food and ultra-violet light. From the one we learn the necessity of the rapid distribution of our food supply before its high energy is lost, from the other we gain a real understanding of the benefits of ultra-violet light therapy, and, more important still, of the dangers of its misuse. We gain an insight into the chemistry of vitamins, which in the light of our new knowledge reveal themselves as stores of high energy, bottled sunshine so to speak, which yield their energy to restore and maintain the vitality of decadent tissues. A vision thus comes to us of a new chemistry with limits far flung beyond those which constrain our knowledge of to-day, a chemistry which will embrace and co-ordinate not only the properties of inanimate matter upon this earth, not only the wondrous mechanism of the life of man in health and disease, but in addition the stupendous marvels of the birth and growth of the worlds outside our own. From those who would decry this as a mere speculation I beg forgiveness, and plead that speculation based on sure experimental fact is the life blood of true scientific research.

GEOLOGICAL SOCIETY OF LONDON.

June 18, 1928.

The following communications were read:—

A Re-Excavated Cretaceous Valley on the Mongolian Border. By PROF. GEORGE BROWN BARBOUR, M.A., Ph.D., F.R.S.E., F.G.S.

The paper traces the history of successive infillings and renewed erosion of a buried Cretaceous valley 600 feet deep, discovered by the Author in the course of a survey of the Kalgan district, on the Chinese-Mongolian border. The valley, originally cut in pre-Cretaceous lavas, was completely filled by the Nantienmen Beds, levelled off by erosion, and entirely covered by a heavy capping of plateau-basalts.

During late Pliocene times a stream followed part of this old Mesozoic valley-axis

"A year or two later I found olivine-before striking off at an angle. The valley-bottom was again filled up by wind-blown lœss in mid-Pleistocene times, again partly excavated in late Pleistocene, and once more filled with very late Pleistocene or early recent gravels. At present, the course is being opened for the fourth time. The Cretaceous-valley deposit (Nantienmen Beds) has been left clinging to the side-walls in many places, so that it has been possible to trace the old landscape and to compare this with the present topography.

DISCUSSION.

The President congratulated the Author on his clear exposition of this remarkable case of the repeated recurrence of geological action on the same line, which also throws light on the correlation of earth-movements in Eastern Asia. Prof. Bailey Willis, in the Yangtze Valley, described a great Cretaceous peneplane, the Peï-tai, which was followed by three stages, those of deep valley-erosion, the deposition of lœss, and, in the present period, great faulting and uplift. The French geologists in South-Western China and Indo-China have described a great post-Himalayan peneplane which they identified as Peï-tai, but assigned to later than the Middle Miocene; it was followed by the same three stages as those of Willis. The present paper therefore supports Bailey Willis as to the Cretaceous age of the Peï-tai peneplane. The "Third Asiatic Expedition" under Dr. Roy Andrews, at Iren Dabasu, about 250 miles north-west of the Author's area, described four erosion-surfaces with the first just before the Cretaceous; in one case, the beds above and below were separated by a disconformity which supports the long-continued geographical stability indicated also by the Author's evidence.

Prof. W. W. Watts called the attention of the Author to the Trias-filled valleys in the Archæan rocks of Charwood Forest which showed many features like those described by him, such as the re-excavated Blackbrook valley, and others which showed un-excavated Trias clinging to their sides. In these valleys the superposed drainage was guided by the softness of the infilling into the lines of the old valleys; but, where the superposed streams had 'lost their way' owing to thickness of cover, valleys had been left only partly excavated in consequence of the check to erosion due to the crossing of the old, buried, ridges.

Mr. S. I. Tomkeieff said that he had seen a somewhat similar occurrence in Russian Central Asia, not far from the Mongolian border. In the chain of Ala Tau (the northern chain of the Tian Shan system) north of the lake Issyk Kul, a deep depression in rocks of granitic and gneissic composition, is completely filled up with a very thick accumulation of lœss. The depression, which may be buried pre-Tertiary valley, or a graben, runs almost parallel with the ridge, and extends for about 15 to 20 miles. The recent river-valley is cut through it approximately at right angles.

The Author said, in reply, that ancient 'fossil' valleys were doubtless of more frequent occurrence than was usually recognised, especially in association with coarse continental deposits. The unusual features of the occurrence described from the Kalgan area are (1) the repeated altternation of erosion and deposit along the same course at geologically distinct intervals, which can be dated with considerable accuracy; and (2) the preservation of the Cretaceous valley-surface in such a manner that it can be mapped and contoured.

The Volcanic Complex of Calton Hill (Derbyshire.) By SERGEI IVANOVICH TOMKEIEFF, F.G.S.

The volcanic complex of Calton Hill shows phases of vulcanicity :—

(i) *Effusive phase—represented* by, besides the agglomerate and tuff of the old *volcanic cone, a highly decomposed lava.* Petrologically and chemically it is comparable with the other contemporaneous Lower Carboniferous lavas of the district. The vesicles are filled up with a chlorite of delessite type.

(ii) Intrusive phase—represented by a fresh analcite-basalt, which has intruded into the old volcanic chimney and spread amœba-like in the volcanic cone, detaching large masses of vesicular lava. Besides abundant analcite, mostly *in the form of* spheroids, the basalt contains numerous inclusions or peridotite. These inclusions, apparently represent shattered fragments of a pre-existing rock, and contain, besides the normal pyroxene, a definite hydrous augite.

DISCUSSION.

The Secretary read the following extracts from a letter sent by Dr. H. H. Bemrose :—

"I fine that he (the Author) confirms the opinion that Calton Hill marks the site of a volcanic vent, an opinion which I expressed 21 years ago before any excavations had been made through any of the Toadstones (except that in Tidewell Dale, very many years before).

and augite-nodules from some trial-holes and the commencement of the quarry which I described 18 years ago in the *Geological Magazine*. I then took the view that the nodules were segregations from the magma, not enclosures of older rock. Further quarrying operations have taken place since then in the hill, and the Author has been able to unravel the complex. From the evidence that he has obtained he concludes that they are the shattered fragments of a pre-existing rock. The late Prof. T. G. Bonney held this view."

Prof. W. G. Fearnsides congratulated the Author on his courage in plotting on a map the intricacies of the Calton Hill igneous complex. As the removal of stone for road-metal had proceeded, the relative proportions of tuff, lava, and sound doleritic rock open for inspection in the walls and sides of the quarry had changed considerably. The area so far attacked by quarrying is a small part of the square mile or so of obscure, but probably continuous, igneous rock-exposure, and the speaker deemed it unwise to express an opinion as to the relations of the intrusive rock to the centre of the vent. The Author's discovery of fresh, hydrous augite in this Derbyshire analcime-bearing rock was a find of considerable importance.

Prof. G. B. Barbour asked what were the optical differences and petrographic relationships between the two types of augites, anhydrous and hydrous, described from the Calton Hill intrusive.

The Author said that he agreed with Prof. Fearnsides that the quarry occupies too small a proportion of the hill to enable us to restore the whole of the volcanic complex.

In reply to Dr. Barbour, he said that, apart from the difference in the refractive indices, there is hardly any difference between the two augites of the periotite-inclusions as seen under the microscope.

At th meeting held on May 9, 1928, *Prof.* J. W. Gregory, D.Sc., F.R.S., presiding, the following communication was read :—

The Geology of the District Around Meifod (Montgomeryshire). By William Bernard Robinson King, O.B.E., M.A., F.G.S.

The general succession in the district may be summarised as follows :—

Salopian.—Banded silts and mudstones (zone of *Cyrtograptus murchisoni* at the

Passage-beds—mottled grey and blue mudstones.

Valentian.—Pale-grey and maroon muds, with occasional black bands up to 2 inches.

Grey-blue mudstones, with calcareous and siliceous bands : many shelly fossils. Probably the base of the Upper Valentian as defined at Llandovery.

Mudstones similar to the above, but the fauna indicates a Lower Valentian age for the beds.

Basal sandstone, with calcareous masses in places. The sandstone fills hollows in the underlying Ashgillian strata.

Unconformity.

Ashgillian.—Buff-grey mudstones. The upper part yields an abundant fauna with *Calymene quadrata.* The lower part yields the *Phillipsinella-parabola* fauna.

Caradocian.—Black graptolite-shale, with basal phosphate-beds resting upon the arenaceous Caradocian.

In this area it has been possible to divide the Caradocian into six sub-divisions, each characterised by a special fauna; but it is suggested that the incoming of certain of these faunules is more controlled by the type of sedimentation and food-supply than by time.

The evidence of marked unconformity at the base of the Silurian is striking at certain localities, and in conjunction with the ground on the east shows that the base of the Lower Valentian gradually transgresses the Ashgillian until some 1200 feet of strata are cut out.

The fact that the whole of the Gala, from the zone of *Monograptus turriculatus* to that of *M. crenulatus* inclusive, is represented by some 800 feet of fine grey and maroon shales is in striking contrast with the developments in Shropshire and the Midlands on the east, or in Central Wales on the west.

A suggestion is offered to account for the zone of maximum sedimentation being separated from the coastal deposits by a thin but complete succession of beds of fine-grained texture.

ORIGIN OF JAPANESE PETROLEUM.

By Kiuhei Kobayashi.
(Waseda University, Tokyo, Japan.)

It is very interesting to note that there are very close geological relations between the oil fields (Echigo, Akita and Aomori, etc.) and the outcrops of Japanese acid clay

Petroleum is accompanied almost always with salt water in Japan.

I have obtained very dilute hydrochloric acid by dry distillation of the mixture of the acid clay and sodium chloride.

Sodium chloride, aluminium chloride and free mineral acid such as hydrochloric acid, will also give some effect for the formation of petroleum from fish oil in the earth crust.

My opinion for the formation of Japanese petroleum and oil gas is as follows :

1. The origin of Japanese petroleum and oil gas *is* of *marine animals.*

2. Putrefaction takes place at first stage. Albumen, etc., of fish are eliminated.

3. Fish oils decompose to fatty acids and glycerine by the action of hydrolysis.

4. Petroleum and oil gas are the products of destructive distillation of above-mentioned fatty acids and glycerine, mixed and covered with colloidal clay, such as Japanese acid clay, on the strata of those fish remains.

5. The hydrocarbons of naphthene series (Higashiyama, Nishiyama and Niitsu oil) are probably the products derived from low unsaturated fatty acids. The hydrocarbons largely of the C_nH_{2n-2}, C_nH_{2n-3}...... series (Kitano, Hara and Ojiya Oil) are the products derived from highly unsaturated fatty acids.

Note :—I have obtained petroleum from *sardine oil and salmon oil by above-mentioned* method. On a recent investigation I have obtained 62 per cent. of oil distillate, of specific gravity *0.854* and *saponification* value 23.3, from a dark expressed fish oil, of specific gravity 0.943 and saponification value 184.9. In future, it will be expected that many kinds of fish oil and some fatty acids may be used for manufacturing gasoline, naphtha, and illuminating oil, etc., from an economical point of view.

GOLD-BEARING AREAS IN NOVA SCOTIA.

Valuable detailed information concerning the gold areas throughout the province of Nova Scotia is contained in Part II. of the Report of the Provincial Department of *Mines for 1927, just issued.*

The Report crystallises a great wealth of information which in the past has taken no definite form. This will be most valuable, particularly for companies and private individuals who are interested in Nova Scotia gold mining developments.

SOLE REPRESENTATION,

Chemical-Technical Line for Ungaria is requested by

P. STEINBACH,

Chem. Ingen. BUDAPEST V,

AKADEMIA UTCA 11.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the *Official Journal of Patents,* and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

18,888.—Distillers Co., Ltd., and Gilmour, R.—Purification, etc., of lactic acid. June 25th.

18,745.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of carbon monoxide. June 28th.

18,828.—Imperial Chemical Industries, Ltd.—Recovery and purification of anthraquinone.

18,550.—Soc. Anon. M. Naef et Cie.—Preparation of lactone of 14-oxy-tetradecane-1-carboxyl acid. June 26th.

18,806.—Soc. Generale Metallurgique de Hoboken. — Manufacture of sulphuric acid. June 28th.

Specifications Published.

292,749.—Synthetic Ammonia and Nitrates, Ltd., and Ewan, T.—Production of hydrocyanic acid from formamide.

Abstract Published.

290,523.— Acetaldehyde; acetic acid. — Goldschmidt, S., Karlsruhe, Germany.

In the manufacture of acetaldehyde and acetic acid from a mixture of ethyl alcohol vapour and air or oxygen with the use of silver as a catalyst, the catalyst is maintained at a temperature of 380-440° C., and preferably between 400 and 420° C. If the *heat of reaction is insufficient to maintain* the desired temperature, the reagents or the catalyst may be separately heated. For example, the air or the mixture of air, and alcohol vapour may be pre-heated by the heat of the reaction. Preferably, however, temperature is adjusted by regulating

the speed of the gas current or by varying the proportion of oxygen in the mixture. It is preferred to use a comparatively small or no excess of oxygen. The reaction may be performed at diminished, ordinary, or elevated pressure, and the reaction products should be rapidly cooled. In one example, air saturated with ethyl alcohol vapour is passed over or through silver wire gauze at such a speed that the temperature of the catalyst, as measured by a thermocouple, remains at 408-410° C. Instead of silver wire gauze, the catalyst may be silver deposited on a carrier such as asbestos. Another example describes the treatment of a mixture of air and ethyl alcohol vapour containing an amount of oxygen only 30 per cent. in excess of that necessary to convert all the alcohol into acetaldehyde.

The Latest TRADE MARKS

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491,549.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — The Caledonian Electro-Chemical Company, Ltd., 167, St. Vincent Street, Glasgow, C.2., Scotland. July 4th.

ANDRESA.

491,280.—All goods in class 1 which includes acids, potash, salts and other chemical substances used in manufactures. — I. G. Farbenindustrie Aktiengesellschaft, Mainzerlandstrasse 28, Frankfort-on-Main, Germany. July 4th.

PRAFORMIN.

490,746.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy. —Nordmark-Werke Aktiengesellschaft für Angewandte Chemie, Humboldtstrasse 54, Hamburg 21,

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MORE DIRECT AVENUES TO CHEMICAL TRAINING.

By ROBERT SAXON, B.Sc., F.C.S. (Lond.), M.A.C.S., M.S.C.I.

Though it is essential to the growth of chemical truth that a devotedness to untiring efforts to eliminate error in research, and that to such end mathematics must always play the part of referee, yet it is a priori necessary that the beginner in such a quest should conceive as an absolute element of success a profound love for science. He should not of course look to it *for amusement. It should appeal to him* from the beginning as a most delightful vista, as a world full of richness could he but find the way. Then he will, like a young bird, keep on trying his wings to see what happens. And like a bird he will not grow sick at heart if at the first attempt he fails to soar but, lost in a whirling world of unshaped impressions, he suddenly finds the earth. He will be impelled by the fact of having wings to try again.

Now nothing sickens the budding scientist more than to lose the drift of a reaction by the hazily attendant mathematics, the mass of symbols, signs and cyphers that if they speak, speak an unknown tongue. If he fails to understand he will surely fail to love the argument that would lead him to clearer vision. Without reasonableness there cannot be interest. No one falls in love with a grotesque monster because one cannot see the reason for it. Dr. Johnson has said that the picture of a woman preaching was like that of a dog standing more or less upright on its hind legs—one wondered how it was done and why it was done at all. To the doctor such a thing was unreasonable *and therefore without appeal to him.* To us well, we have to stand it. However, with regard to science philosophy and its presentation to the young the mathematics should always be so arranged as to clearly support the theory, and not the theory to excuse the mathematics. Let us choose therefore weights, volumes, etc., of reacting *substances to bring into play readily* grasped ratios and proportions or differences or whatever we are attempting to rely upon for our appeal.

Take a crystal of copper sulphate, called a vitriol or glassy growth like iron sulphate called by the ancients green vitriol a name culled from ' vitrum,' said to mean ' glass.' References to history always appeal. Give green vitriol as the source of oil of vitriol without bothering about the eqnation, and the name of one of the commonest reagents has a reason. Blue vitriol has been so called by analogy as is the case with white vitriol. Quartz would appeal to the ancients as a transparency but they did not call it vitrum but ' crystallus,' from a root meaning hard cognate with ' crust,' ' cruel,' and the Latin words ' cruor ' gore, and ' crudus ' raw, this last being akin to the root. Crystal was supposed to be ice frozen so hard as to resist all efforts to thaw it. Colour was sold in waxy colloid lumps looking very much like green vitriol, and there is no reason why it should not have been called green woad.

This blue vitriol was a valuable source of *necromancy to the quacks of old.* It was one of the strongest supporters of the theory of transmutation and was used wet on iron to pose as a feeble brother of the philosophers' stone.

Copper sulphate has a sensible molecular weight as $CuSO_4 5Aq$, namely 250, a strong recommendation as a first reagent. By desiccating it in a bulb tube the water of crystallisation may be seen. This desicca*tion is made a gravimetric test and the facts* are recorded as follows, the *facts of observation* being referred to *on the left*, and the *facts of deduction on the right* of the recorded quantities, thus (x = any figure)

I	Wgt. of App.	x.xxxx	(Let App. = crucible, etc.)
II	,, ,, + salt	x.xxxx	
III		x.xxxx	Wgt. of salt
IV	1st wgt. of II after heating	x.xxxx	
V	2nd wgt. after 2nd heating	x.xxxx	
		0.0000	difference.
VI		x.xxxx	wgt. of residue.

These crosses merely show the places occupied by digits. In an actual experiment where 2.5 grams of finely powdered copper sulphate was taken the residue weighed 1.585 grams, and a number of such experiments gave an average of 1.589 grams. As only two in a class of twenty-five were far from the mean their findings were ignored, but they were made to repeat while the others watched and then they came within reasonable distance of truth. It does not do to leave out these ' sports ' as they might

still be correct in the opinion of those who are sceptically minded with regard to the dictates of scientific research.

Don't bother about percentages. Get a clear diagrammatic conception in the mind of the beginner of the simplicity of chemical architecture. In too many cases gravimetric research with beginners is a guessing *competition, the master being in possession* of the answers. He flounders about until he gets the correct percentage loss. This floundering is supposed to teach him " the use of apparatus," or keys which tell him what he should get. By so working for the general result he is merely practising what the world of science uses as its test of new theories, their acceptance by the vast majority, and their squaring with other accepted facts. Nothing is learnt by trying to please the science teacher or rather trainer. Trust, as far as our intellect goes, must be the opinion of the great majority for the time being. These percentages kept the simple laws of simple proportion in compounds locked up in the dark for ages. For beginners they are better avoided.

Having got white copper sulphate from the blue let the student write in his note-book :—

Blue copper sulphate : white copper sulphate = *250 : 160 = 25 : 16.*

If a tube carry a bulb at each end containing in one 25 parts of the blue and in the other 16 parts by weight of course of the white, the bulbs being equal in weight, and the tube uniform in bore and sealed, a point will be found as fulcrum on which the whole will balance : If, however, the blue end be heated it turns eventually white and a fresh fulcrum is required to secure equilibrium. Such a ' Barbel ' may be constructed easily and if its total weight equals the total weight of the contents it may be arranged to illustrate the ratio by the position of the fulcrum.

Take 2.5 grms of blue sulphate and dissolve in 100 ccs of water. Write— 2.5 : 100 =25 :1000 but as 250 gms of copper sulphate in 1 litre of water is a Normal Solution, ours is said to be *Decinormal.* We might weigh 1.6 gms of the white and dissolve to the same strength. Note that when we say " in 100 ccs of water " we mean to make up the volume of water and salt 100 ccs. The difficulty is to be sure that the white is absolutely dry, or as dry as we can make it. However, this drying and weighing will serve to illustrate the necessity of " calcining to constant weight."

A TEST FOR WATER AND AMMONIA.

Drop one lot of white copper sulphate into water and another in ammonia solution in tall glass jars. Try other liquids colourless but free from water, and note—

Anhydrous (explain) copper sulphate turns blue in water,

Anhydrous (explain) copper sulphate turns deep blue in ammonia.

Evaporate and get crystals of—

I. Blue vitriol,

II. Copper sulphate ammonia, more or less pure.

DISPLACEMENT, BASICITY, AND FORMULA.

Take our centinormal weight (2.5 gms) of copper sulphate crystals and dissolve in water. Weigh out 0.24 gms of magnesium, and drop into solution and note—

I. A dark powder is deposited on the metal.

II. This is red in air, being copper

III. *With certain strength of solution the* blue green of the copper sulphate finds *Complementary Colour* in copper which metal looks like silver.

IV. The blue colour completely disappears. This is an introduction to the *end point* of a reaction. This end point if not actually reached in one case may be secured by mixing a few together. In such cases the student sees the advantage of averaging, and how *experimental errors by the law of averages neutralise one another.*

Weigh the copper after drying carefully and note—

Magnesium dissolved in solution : Copper pushed out = 24 : 64 = 3 : 8.

Now as students, and professors for that matter, cannot visualise atoms and molecules except as letters on flat paper, even of the simplest compounds, the student might as well be introduced to these typographical assemblings and groupings at first. There is nothing to prevent him evolving a three-dimentional universe of rotating and revolving nuclei and ions in his imagination later on. All our valency science is laid out on flat paper, and some of the silicates according to some textbooks are like kindergarten apple trees, and organic compounds a boy's first essay in wall-paper designs. The only thing certain is that these arrangements pan out with some facts and that there is no known fact to prove that such arrangement is impossible. No one however can imagine that in copper sulphate, copper, sulphur, and oxygen atoms exist in the molecule in the relative position outlined by the written formula. We cannot say that the

sulphur separates copper from oxygen for instance. *All we need say is that according to theory the smallest possible part* of the blue *substance that could be conceived to* exist without breaking down into something less complicated is called the *molecule*, that every molecule of the blue substance is exactly like every other molecule of the same substance, and such molecule if broken up gives us one so-called atom of copper, one of sulphur, and four of oxygen along with 7 molecules of water, which latter breaks up into atoms of hydrogen and oxygen, two of the former to one of the latter to every molecule. An *atom* we may say cannot be broken up to give anything else. We may then write the formula for white and blue copper sulphate and the equation giving the displacement by magnesium of the copper. If he understand the theory he will realise the homogeneous character of the crystal and metals and see that the equation tells the story of the molecule of magnesium usurping the place of copper in two molecules of copper sulphate, turning out two atoms of copper to make one molecule of copper. He will understand this as concretely now as at the end of his college course.

Evaporate the colourless solution carefully and slowly and get beautifully clear and transparent feathery crystals of magnesium sulphate or Epsom Salts. From time to time near the end use centrifugal swinging to get charming growths clinging to the vessel sides.

Draw attention to the constancy of the ice under similar conditions, showing that to build on perpendicular lines like those of gravity rectangular blocks are needed, for horizontal hexagonal lines like those of angle between branches, and compare with honeycomb, dihedral angles of 120 degrees are essential, and for architecture of myriad walls radiating from radiating walls like our growth of crystals *Blocks of Constant Dihedral Angle* must be used to get constant angles at every corner. This may be illustrated diagrammatically by ruling paper with that constant angle series of intersecting lines. Thus for water we draw lines at equal distances representing distances between planes of cleavage (so infinitely small as to approach nothing as nearly as sulp. approach absolute zero in freezing 1.585 gtus—ours is a diagram not actuality) ments gting at 60 degrees. We can shew how ter how individual crystals do tions at any other than the constant angle. Other angles may be taken to show irregular growth, and coming out of the plane of the paper show trihedral angle cleavage starting with the cube, and developing the truncate cube, tetrahedron, and octahedron. These may be sketched in growth, or they may be represented twinning in geometrical projection to the usual three planes. The following rough delineations are in the nature of suggestions rather than material for copy. The student who has no sense of the third dimension has a stunted sense of construction, without which invention is impossible. He should therefore understand these. The fact that magnesium replaces copper brings out the fact that magnesium is more basic than *copper or magnesium is more electro-chemically positive than Copper*, and show the class a list of a few well known elements as an *Electromotive List*, choosing only those it is intended to try. The full list may be shown later.

Titration and Basicity.

Now take 0.124 gms of pure copper carbonate, add water and run from a burette decinormal sulphuric acid. Record—

Burette initial xx.x
,, final xx.x
xx.x ccs. H_2SO_4 taken

The end point is the reading before the last drop failed to produce effervescence. Note—

I. Green of carbonate gives place to blue.
II. Water lets carbon dioxide through but keeps back salt.

III. Water cannot lessen the amount of receptive salt (the salt we run the reagent to), so that generally we may after putting the measured quantity under a burette run as much water as we please to it.

Weigh as anhydrous copper sulphate and record thus—
$CuSO_4 : CuCO_3$ = 160 : 124 = 40 : 31, or nearly 4 : 3.

Repeat the titration with fresh carbonate using methyl orange as indicator, showing previously the action of sulphuric acid on it. This enables the end point to be more easily struck but the acid pink has a peculiar effect on the copper blue obscuring the main issue the change from green to the ionic blue.

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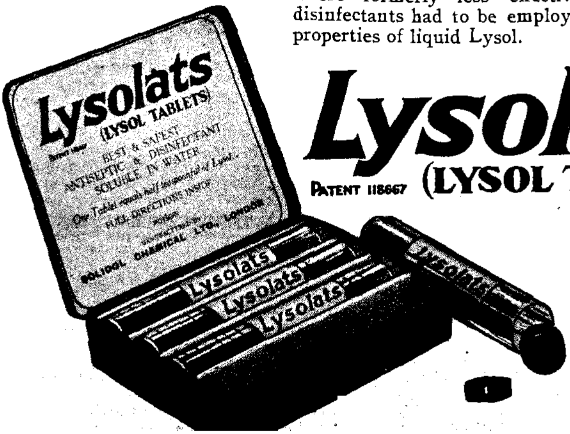

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THE PART PLAYED BY BRITISH WORKERS IN THE APPLICATION OF FIXED NITROGEN TO THE SOIL.

By Sir John Russell, D.Sc., F.R.S.

Read at the Chemical Conference on May 15.

(*Continued from Page 39.*)

Manuring of Grass.

Special interest attaches to the manuring of grass. The Rothamsted experiments show that the yield of hay can be pushed up very considerably by nitrogenous manure, and simultaneously the character of the herbage may be greatly modified.

Unlike arable crops, "grass" is not a single crop, but a mixture of many, including some that are not grass at all; on the grass land at Rothamsted there may be as many as fifty or sixty species of plants. On old grass land these have settled down to some kind of mobile equilibrium, so that the whole flora can be recognised as essentially the same in different seasons. On addition of fertiliser, however, the equilibrium shifts; the fertiliser favours some species more than other and these grow more vigorously, crowding out those which are less responsive. By suitable combinations of fertilisers, however, it is possible to retain a valuable type of herbage and at the same time to obtain high yields.

This knowledge has long been available; only recently, however, has it been applied to grass used for grazing. It has long been known to graziers that young grass has a special nutritive value and that only by close grazing can the best results be obtained. The essence of the method, now so much discussed for treating grazing land, is to manure heavily with a mixture of fertilisers that will maintain the desired flora, and to graze closely so that the grass can never grow up. The technique of the method necessitates the setting up of fences and the laying on of water, sometimes so costly as to be prohibitive.

The effect of time of application of nitrogenous fertilisers is not yet fully known. For cereals the application of sulphate of ammonia with the seed increases the total number of tillers, and the number of tillers that bear grain, but it does not, so far as the counts have gone, increase the number of florets or of grains to the ear: indeed, there is an indication of a small decrease in the number of fertile grains per ear, though a large increase in the total number per acre. The action of late dressings of sulphate of ammonia is very interesting. The data are insufficient for us to speak with certainty, but it appears that nitrogen applied after tillering has ceased is used for putting heads on to tillers that would otherwise bear none, and therefore increases the amount of grain in proportion to the straw. Where, however, most of the tillers are already grain bearers, the nitrogen cannot produce this effect and so is merely stored in the plant where it may prove useless. It then increases the percentage of nitrogen in the grain.

On potatoes the late dressings are not effective and it is more economical to apply the whole dressing with the seed. Possibly this is true also, of mangolds and sugar beet, but the problem is not yet settled.

The Effect of Nitrogenous Fertilisers on Barley.

The influence of nitrogenous fertilisers on the composition of the crop has been studied in great detail for barley and for sugar beet. For barley it is known that small dressings of nitrogenous fertilisers lower the percentage of nitrogen in the grain while larger dressings raise it; the difference is probably associated with the differing effects of successive increments in the early part of the curve. It is simplest to assume that the additional nitrogen in the grain resulting from the action of excess nitrogen in the fertiliser represents storage products. The problem is being studied in some detail for wheat and barley. For wheat, additional nitrogen is an advantage when it is associated with additional "strength" of the flour; the association, however, is not invariable and attempts are being made to trace it out fore fully. For barley the additional nitrogen may be a disadvantage as it may lower the value for brewing. This is being studied at Rothamsted by Mr. L. R. Bishop, working under the Institution of Brewing Research Scheme. He finds that the nitrogen compounds of the barley grain fall into three groups; one which increases; proportionately as the nitrogen increases; a second, hordein, which increases more than proportionately to the nitrogen; and a third group which increases less.

It follows that a barley of high nitrogen content differs from one of low nitrogen content not only quantitatively in containing larger amounts of nitrogen compounds, but also quantitatively in that the nitrogen compounds are there in different proportions; in particular, it contains more hordein. How this affects the malting and brewing processes is not yet known.

The field experiments thus show that the nitrogen in the grain can be increased by increasing the amount of nitrogen supplied as fertiliser, by putting it on later, or by sowing the seed later; meterological obser-

vations show that the nitrogen of the grain tends to be higher after a dry spring than after a wet one; it can be decreased by early sowing, by using potassic fertilisers (though this is only a slight action), and it is decreased by spring rain. These variations are most marked on very light soils in moist conditions. The nitrogen content of the grain is thus somewhat under the grower's control and it is in large measure determined in the early days of the plant's life. Efforts are being made to find means for estimating its probable value during the growing season and before the grain comes to be harvested and sold: this would have considerable commercial value.

The Effect of Nitrogenous Fertilisers on Sugar Beet.

Many investigations have been made on the effect of nitrogenous fertilisers on the composition of sugar beet and of mangolds, particularly on the percentage of sugar in the root, and in the dry matter. Broadly speaking, small quantities have but little effect: large quantities may reduce the dry matter in the root, but not necessarily the percentage of sugar in the dry matter. The problem is complicated by the action of the potassic fertilisers, almost invariably used for these crops, and by the seasonal factors. A detailed investigation is now in hand at Rothamsted; investigations have also been begun on potatoes.

The modern investigations on nitrogenous fertilisers are showing agriculturists how to increase the quality of their vrops and how also to effect modifications in composition and habit of growth that will enable them to overcome any disadvantages, and make full use of any advantages, in their natural conditions of soil and climate. Under modern conditions, crop production is always on the verge of unprofitableness, so that the highest degree of efficiency in protion must always be sought. Among the various methods for increasing efficiency the scientific use of fertilisers is one of considerable promise. Investigations are being pursued much more vigorously at the present time than at any previous period, thanks to the Research organisation of the Ministry of Agriculture and to the enlightened attitude of the large organisations dealing with fertilisers.

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We have received a catalogue (dated July, 1928), of fine chemical products issued by the above well-known Company.

GENERAL NOTES.

NEW KODAK ENTERPRISE.

Research Laboratory to be Established in London.

It is announced that Kodak, Ltd., is to establish a research Laboratory in London.

The Eastman Kodak Research Laboratory at Rochester, N.Y., is recognised as one of the foremost in the world, and has been responsible for many important industrial developments. It is under the directorship of Dr. C. E. K. Mees.

The London laboratory will be developed on similar lines, as part of the Kodak factory organisation at Harrow, and will be under the direction of Dr. Walter Clark.

Dr. Clark was educated at Christ's College, Finchley, N., and University College (University of London). He took his degree as Bachelor of Science (1921) with honours in chemistry; Master of Science (1922); Doctor of Philosophy (1924). He is also a Fellow of the Institute of Chemistry and Fellow of the Royal Photographic Society. Dr. Walter Clark was for five years at the British Photographic Research Association; and later at the Science Museum, South Kensington. He was hon. secretary of the Seventh International Congress of Photography (1928).

WHOLESALE PRICES IN JUNE.

Board of Trade Index Number.

As measured at the Board of Trade, wholesale prices in June were on the average lower than in May by 0.6 per cent., the index numbers for the two months being 85.9 and 86.4 respectively (1924 = 100). the June index for food is lower than the May figure by 1.1 per cent., and a similar comparison in respect of industrial materials shows an average price fall of 0.4 per cent. In the group indices the only rise of importance is that of 1.8 per cent. shown for meat and fish. This is the third consecutive monthly rise recorded in the index for that group. Cereals fell by 2.4 per cent., and miscelaneous foods by 2.6 per cent., comparing the averages for June with those for May. Both cotton and other textile materials fell by 0.8 per cent. and miscellaneous industrial materials by 0.7 per cent., while for iron and steel and other metals and minerals the respective price levels are about the same for the two months of May and June.

THE MOND NICKEL RESEARCH DEVELOPMENT DEPARTMENT.

Over two years ago a new department was established with the following objects in view :—

(a) The collection and recording of all information concerning nickel and its alloys which is in existence or which becomes available either through the technical press, Societies' Transactions, etc., or more directly from interested metallurgical and engineering industries.

(b) The examination of both established and newly discovered alloys of nickel, their production, properties and applications, and the development of new alloys and uses.

(c) The placing of the information obtained freely and fully at the disposal of Industry.

(d) Collaboration, when desired, with anyone interested in the manufacture, fabrication or utilisation of nickel and its alloys.

The past two years have been spent in collecting and indexing information and in establishing an organisation to carry the above aims into effect. We are commencing a series of publications which we hope to prepare and distribute at regular intervals.

Beginning also with the month of July, 1928, the Department commenced the issue of a monthly *Bulletin*, which will contain abstracts of all references to nickel of technical interest appearing in current publications, together with information regarding the location of other articles, etc., of possible value to metal users. In addition, some aspect of the metallurgy of nickel and its alloys will be dealt with more fully each month. In this way it is hoped to draw the attention of the recipients to published information on nickel as soon as it is available.

SCIENCE AND RESEARCH.

" I think it is impossible to over-rate the national importance of contentment in employment. If a man likes his work and is interested in it, he is a far better citizen than if he is merely performing what is to him daily drudgery."

In the above words, Dr. Francis Freeth, F.R.S., speaking on June 29th on behalf of Lord Melchett (President) to the Annual Meeting of the Association of Technical Institutions at Cardiff, emphasised the value of technical education in industry and in national life as a whole.

Dr. Freeth, expressing Lord Melchett's regret at his unavoidable absence, referred to the tremendous increase in the number of matters with which Lord Melchett had been concerned within the past twelve months. He referred particularly to the Conference on Industrial Reorganisation and Industrial Relations, the possibilities of which could not be over-estimated and which will hold its next full joint session at Burlington House on Wednesday next.

Proceeding, Dr. Freeth said that the technical institutions of Great Britain have played and are playing a very important part in the life of the community. Their path, however, is beset with many difficulties. Technology is of course far older than science or than education in the modern sense of the word. The early arts, metal working, pottery, glass-making, etc., were handed on from father to son and from master to pupil throughout the generations. It is fair to assume that such instruction was conveyed more or less traditionally and that there was little or no attempt to analyse the operations involved or the reasons of their sequence. The teachings of the traditional methods of work are very frequently right and it often happens that modern science can only give a logical explanation of what was previously accepted as a fact. Such methods of education, however, are totally inadequate to meet the needs of the modern industrial world.

The dawn of modern science which might be assigned to the beginning of the nineteenth century was responsible for the conversion of Great Britain from an agricultural country into an manufacturing one. New industries demanding a skill and knowledge on the part of the worker far greater than ever he had been expected to display before were among th causes which called technical institutions into being. It would be a fair parallel to regard technical training as a consolidation of the advances of science for industrial practice.

One of the most valuable services which the technical colleges can render to the community is not only to train workers who can hold their own technically with those of any in the world, but what is far more important to promote in each of the students a really healthy creative intelligence in his job and pride in his particular sphere of operations. There are few employments in technical life which cannot in the proper hands be made to yield interest in some form or another.

Dr. Freeth then referred to the manner in which the constituent firms of Imperial Chemical Industries Limited had always en-

couraged technical education among the workers. As an example, he said that Brunner, Mond & Co. have just erected a great new research laboratory and they are now launching out on a scale the magnitude of which is of a different order than anything they previously contemplated.

At the present moment the chemical industry is undergoing a rapid expansion and is enlarging its horizon in every direction. The backbone of the industry—the production of heavy chemicals such as soda ash, caustic soda and chlorine—that is to say the heavy chemical industry of Great Britain has always maintained its supremacy in the face of foreign competitors and is now in a stronger position than it ever has been.

The latest and probably eventually the greatest venture, the product of fertilisers from the air, has now assumed gigantic proportions and as yet is only in its infancy. It is a veritable triumph of British chemistry and particularly of British engineering.

Dealing with technical training in the chemical industry, Dr. Freeth gave as an example the pattern makers, skilled craftsmen and tradesmen of all sorts, that silent unrecognised efficient army without which the industry could not last three months. He emphasised the vast importance of instruments of every sort in modern works and factories. Modern industry depends more and more on its instruments as it becomes more quantitative and less empirical.

Dr. Freeth paid a big tribute to the vigorous and efficient technical schools of Cardiff, and in conclusion he said that international competition had never been keener than it was at the present time and our industrial rivals, especially on the Continent have made tremendous efforts in the direction of technical education. It is not too much to say that industry in this country looks to the technical colleges for a great measure of assistance in that industrial revival of which we see signs on all sides.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

June 21, 1928.

The following papers were read in title only :—

The Structure of Thin Films.—Part XI. By N. K. Adam. Communicated by Sir. William Hardy, F.R.S.

With the object of measuring the cross-section of the benzene ring, in the plane of the ring, the behaviour of various derivatives of resorcinol and phloroglucinol, with long chains in the ring, has been studied in the monomolecular surface films.

The main object has not been attained, since no substances could be found which formed films in which the benzene ring was both lying flat on the water and packed closely against the rings of neighbouring molecules in a similar position. In some cases, the rings stood upright, forming a condensed film, much like those of the long chain phenols previously investigated.

These films were generally given by the compounds in which the hydroxy groups in the resorcinol or phloroglucinol portion of the molecule were not substituted. With methyl ethers, " expanded " films were obtained, in which the molecules probably had benzene rings flat, or nearly so, but the films were very compressible, and it could not be determined whether the rings were flat and in contact at any area. The results throw some light on the effect of localised cohesive forces at different points on the molecule, in orienting the molecule. The hydroxyl groups in the ring increase the attraction of one ring packed face to face on another, and this increase is more important for orientation than the increase in the attraction for the water, caused by the hydroxyl groups. In the case of compounds with a resorcinol group at each end of a long chain, which form gaseous films, cohesional corrections to the gas laws are diminished by acetylating the hydroxyl groups, and the area of the molecule is increased, confirming the view that the molecules lie flat in the gaseous films.

Metal Overvoltage Measurements with the Cathode Ray Oscillograph. By E. Newbery. Communicated by Sir Ernest Rutherford, O.M., P.R.S.

From experiments on metal deposition with the aid of the cathode ray oscillograph, it is shown that overvoltage and transfer resistance do not occur unless a gas is being liberated at the electrode. Hydrogen is always deposited along with metal when the metals of the ion group are separated electrolytically from pure solutions of their respective salts, and this gives rise to hydrogen overvoltage at the cathode.

The reason why the metals of the iron group show this exceptional behaviour is discussed, and it is shown that it is probably due to hydration of the ions of these

metals. A defect has been discovered in the design of the cell previously used for these experiments. This defect is responsible for erroneous values for transfer resistance, but has no effect upon the values for overvoltage.

Photoelectric Effect of Soft X-rays. By G. B. Bandopadhyaya. Communicated by O. W. Richardson, F.R.S.

The number of photoelectrons liberated from twelve different elements (C, Al, Fe, Ni, Co, Cu, Mo, Ag, Ta, W. Pt, and Au) under soft X-rays from a copper target has been measured with a special quartz tube.

The relative photoelectric sensitiveness of different elements found experimentally is of same order as observed under ultra-violet light.

The experimental results of critical potentials obtained by different investigators have been carefully examined, and from an analysis it is inferred that under soft X-rays by far the greater number of photo-electrons come from the valency orbit, or from orbits very close to it, and having energies below 10 volts.

Richardson's law of liberation of photo-electrons has been applied, and a formula deduced which explains linear variation of photo-electric current per unit bombarding current, with voltage for voltages between 50 to 500, as has been found to be the case by Richardson and Chalklin, and also by the present investigator.

On the Chemical Reactions of Carbon Monoxide and Hydrogen after Collision with Electrons. By A. Caress and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

The decomposition of carbon monoxide into carbon and carbon dioxide (also some suboxide), and its union with hydrogen to form formaldehyde (and polymers) under excitation by electron impact have been examined. It is shown that hydrogen atoms produced by thermal dissociation react directly with carbon monoxide molecules, and also react with enhanced efficiency with carbon monoxide positive ions. It is believed that this increase in reactivity is to be attributed to either a chain or a cluster mechanism. Hydrogen molecules react with carbon monoxide positive ions, but more readily with ions excited to the $2\ ^2S$ level: this may be due either to the larger target area of the ion in the $2\ ^2S$ state, or to its greater tendency to form clusters with CO, H_2 and H. Excitation of the normal CO^+ ion and transition to the $1\ ^2P$ state do not affect the reaction rate. No indication of direct decomposition into carbon and oxygen was noted at dissociation potential. Subsequent polymerisation of formaldehyde has been shown to follow a unimolecular law, but is due merely to the slow diffusion of the simple molecules from the pressure gauge. The reaction products have been obtained in quantities sufficient for chemical tests.

The Electromotive Behaviour of Thin Films. Part I.—Hydrogen. By F. P. Bowden and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

A quantitative investigation is made on the changes of electrode potential at the surfaces of metallic cathodes during the electrolytic deposition and removal of very small quantities of hydrogen. It is found that the electrode potential is a linear function of the surface concentration of the hydrogen; moreover, the potential of the polarised cathode depends only on the true surface concentration of the added hydrogen, and is independent of the nature of the underlying metal. Apparent differences observed are due to differences in real areas of cathodes. This gives a method of measuring real areas of metallic surfaces. The amount of hydrogen deposited is small, sufficient to form 1/3000 of an atomic layer, causing a change of 100 millivolts in electrode potential. Rate of decay of electromotively active hydrogen from the cathode surface is an exponential function of potential. General behaviour and magnitude of the quantities involved can be explained on the assumption that electrode potential is due to presence of electric doublets on its surface, the electric moment of these doublets being that given by proton and electron separated from each other by distance equal to diameter of hydrogen atom.

The Electromotive Behaviour of Thin Films. Part II.—The Areas of Catalytically Active Surfaces. By F. P. Bowden and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

Evaluation of real area of cathode surfaces by measurement of amount of deposited hydrogen required to raise potential by a definite increment, and comparison of catalytic properties of these surfaces by observation of rate of hydrogen evolution, has been extended to silver, platinum, carbon and nickel. The effect of amalgamation as well as of treatment of surfaces by alternate oxidation and reduction, annealing, etching with acid, electroplating, sand-papering and rolling have been examined.

It is shown that real area of metal sponge, such as platinum black, may easily attain a value two thousand times its apparent area. Real area of a sand-papered metal is about ten times its apparent area, and in case of nickel activation by alternate oxidation and reduction causes an increase of nearly fivefold. Rolling reduces real area. Specific catalytic activity of various metals differs very widely, but for any one metal specific activity of the surfaces only suffers small variations by chemical or thermal treatment. Violent mechanical treatment, however, such as sand-papering or rolling, causes marked increase in activity, and this gradually diminishes with ageing of cathode.

The Detonation Wave in Gaesous Mixtures and the Pre-Detonation Period. By W. PAYMAN. Communicated by H. B. Dixon, F.R.S.

An experimental method has been developed for photographing the invisible shock or compression waves sent out through a gas mixture on detonation of a solid or gaseous explosive in contact with same, and has been applied to the study of pre-detonation period and inception of detonation in gaseous mixtures.

The effect of position of point of ignition on initial movement of the flame in a closed tube has been examined, and an explanation advanced for the observed retardation of the flame, which sneggests that it occurs simultaneously with break-up of flame front into two separate portions moving in opposite directions.

Visible evidence has been obtained of the movements of the hitherto invisible compression waves, the character of which has been previously postulated from their effects on the flame. These are not due to the spark, as has been previously supposed, the spark-wave being comparatively feeble. The former waves travel at speeds much greater than that of sound in the gaseous medium through which they are passing, and appear to have their origin in the gases through which flame has passed and in which comhustion has commenced some time previously. They appear to be due to renewed chemical activity of some kind behind the flame front. In theh same way ,under experimental conditions, and with mixtures used, the detonation wave always appears to have its origin behind the flame front.

Experiments on the Diffraction of Cathode Rays.—II. By G. P. THOMSON. Communicated by Sir Joseph Thomson, O.M., F.R.S.

Further experiments of the diffraction of cathode rays by three films of aluminium, gold, and platinum show very close agreement with the de Broglie wave theory. Methods are described for preparing the films of the latter metal. It is shown, by deflection in a magnetic field, that the diffracted rays have the same velocity as the undeflected rays within 1 per cent. A large number of diffraction rings can be seen when a magnetic field is used, which is analogous in its action to the achromatising effect of a prism on Newton's rings. The rings are all of the sizes predicted by the wave theory from the crystal structure. From the observed resolving power the minimum number of waves in a train is shown to be about 50 for the beam of cathode rays used. Some experiments on inclined films are in qualitative agreement with theory.

ROYAL SOCIETY OF ARTS.

ANNUAL GENERAL MEETING.

The One Hundred and Seventy-fourth Annual General Meeting for the purpose of receiving the Report of the Council and the Financial Statement for 1927, and also for the election of Officers, was held in accordance with the Bye-Laws, on Wednesday, 27 June. Sir Philip Magnus, Bt., Chairman of the Council, was in the chair.

The Secretary read the notice convening the meeting, and the Minutes of the last Annual General Meeting, held on July 6, 1927.

The Secretary then read the Report of Council, of which we give an abstract :—

I.—ORDINARY MEETINGS.

"The Royal Society of Arts : Its Services to Trade and Training" was the subject selected by the Chairman of the Council, Sir Philip Magnus, for his Inaugural Address. If he found with Lord Sanderson, a former Chairman of the Council, that "the first impression on a survey of the Society's work is one of some bewilderment at the multiplicity of the subjects with which it dealt in rapid succession or even simultaneously," Sir Philip contrived to give as clear a sketch as could possibly be compressed into the limits of an hour's address of the Society's activities extending over 170 years. He referred to the early system of awards which did a good deal to develop the trade and commerce of our colonies; to the encouragement of forestry, which led to the planting of some 50 million trees in the British Isles; to the rewards

granted for meritorious inventions, many of which proved extremely serviceable in promoting industries. But possibly the most valuable part of the address was that dealing with the part played by the Society in the encouragement of technical and commercial education. Himself the senior educationalist of the day, Sir Philip was able to describe the educational movements of the last sixty years with all the knowledge of one who has been the principal pioneer in most of them, and his summing up of the Society's share in this important branch of its activities must make his address a very valuable fragment of educational history.

The tremendous difficulties of the traffic problem, which are tending every year to approach nearer and nearer to insolubility, have now become so menacing that the Council decided to devote three meetings to the consideration of various aspects of them. At the first of these Mr. Mervyn O'Gorman read a paper on "Road Traffic Problems of the Pedestrian." Perhaps the cardinal point advocated with the regulation of the pedestrian in his own interest, and the proposal that the Minister of Transport should publish an authentic code of Road Customs.

The second paper relating to the traffic problem was read by Professor Leonard Hill, under the title "Overcrowding in Public Conveyances." He dealt mainly with the question of ventilation in trains, trams and omnibuses, and gave in detail the results of observations taken with the help of the katathermometer on ventilation in various public conveyances. He also discussed the atmospheric conditions favourable to the spread of "colds" and similar complaints, and commented on the general tendency to keep railway cars too much shut up and too warm. The contamination of air in tunnels with carbon monoxide was mentioned, and reference was made to the great loss of working power and discomfort which tends to ill-health caused by traffic delays due to fog. In conclusion, Professor Hill expressed the view that a serious cause of overcrowding in trains during the rush hours is the division into first and third class carriages, and he urged the speedy abolition of first-class compartments in local trains.

The third paper connected with the traffic problem was read by Major R. G. H. Clements, the title being "The Evolution of Modern Road Surfaces." The enormous volume of present-day traffic and the weight of many of the vehicles have entirely revolutionised the problems of road construction, and although a great deal of work has been done in connection with the subject, it cannot be said that conditions have yet approached standardisation. The paper described the various kinds of road surfaces which are in more common use, *e.g.*, tarmacadam, concrete, wood blocks, asphalt, brick, etc. An interesting section dealt with the use of rubber, which appears to have given remarkable results in wearing properties ,and has obvious advantages in the way of silencing traffic noise and diminishing vibration. The chief drawbacks to its use are the heavy initial cost and the difficulty of anchoring it to the road foundation—a problem that has proved much more difficult than was at first suspected.

Last autumn there was celebrated in Paris the centenary of the birth of Marcellin Berthelot, who may be regarded as the founder of synthetic chemistry. It was felt by the Council that this event ought not to pass unnoticed by the Society, and accordingly they invited Professor Armstrong to read a paper on the subject. Under the title "Marcellin Berthelot and Synthetic Chemistry," Professor Armstrong gave an exceedingly appreciative account of the man and his work.

Mr. T. Hedley Barry, in his paper "Malayan Varnish Resins," gave a comprehensive account of a "minor forest product." After beginning with a description of the typical forestry of Malaya, and the work of the Forestry Department, he proceeded to show how the resin is collected from the trees, and how it is washed, graded and packed in the factories. The various species of resin were then dealt with, and their principal characteristics explained.

"Methods of Radiant Heating" was the title of a paper by Mr. A. H. Barker, in which he began by explaining the differences between conduction, convection and radiation, and the reasons why radiation places the least strain upon the heat-regulating or thermostatic mechanism of the human body, and is, therefore, the most comfortable and healthy method of heating. He then discussed various kinds of incandescent or luminous radiation possessing short wave-lengths, such as coal, coke or wood fires, gas and electric fires, etc., and on the other hand, methods of "dark" radiation, possession long wave-lengths, as for example, wall and ceiling panel heating, and floor heating.

Mr. H. de Koningh's paper, "Enamels, Secular and Ecclesiastic," was divided into

two parts. In the first he described the methods employed in enamelling, the kinds of furnaces used and the processes of firing. The second part was devoted to an account of well-known examples, the earliest of which dated from the Mycenaean period.

A great deal of public interest has been aroused by the discoveries resulting from the work conducted by the joint mission of the British Museum and the Museum of the University of Pennsylvania in excavating the ruins at Ur. Dr. H. R. Hall, who was himself responsible for the first excavations, read a paper entitled "The Excavations at Ur—1919-1926." He showed a large number of slides illustrating the site of the Temple of the Moon God, and many trophies which had been unearthed there, including a great copper relief (now in the British Museum) of a lionheaded eagle seizing two stags, which is one of the most important relics of Babylonian art, dating probably to about 3100 B.C.

"Industry Fifty Years Hence," was the title of the paper in which Mr. Archibald Crawford indicated the direction in which he believed the industrial world is now advancing. After a long struggle between capital and labour he thinks that a time has been reached when each appreciates the necessity to himself and to the country of the other. The General Strike did a very great deal to clear the air, with the result that the relations between employers and employed are now more harmonious than they have ever been since the Industrial Revolution. The idea of partnership between the two is steadily growing, and instead of antagonism there is an increasing tendency towards co-operation.

Astronomic figures are apt to prove bewildering to the lay mind, but probably none more stupendous were ever put forward than those suggested by Dr. J. H. Jeans, who delivered the Trueman Wood Lecture on "The Wider Aspects of Cosmogony." The evidence of geology and of radioactivity in rocks shows that the earth must be something like 2,000 million years old, and a million million years hence, so far as can be seen at present, the sun will be much the same as now and the earth will still be revolving round it, and this in spite of the fact that the sun is wasting at the rate of 360,000 million tons a day. The number of stars in the universe is estimated at $(2 \times 10)^{24}$; in other words, the same number of grains of sand spread over the whole of England would make a layer hundreds of yards in depth, while as for the immensity be obtained from the statement that light, which can travel round the world in the seventh of a second, would probably take something like 100,000 million years to travel round the universe.

The scientific cultivation of rubber can only claim to be about a generation old, and it is therefore natural that great developments should have taken place in it during recent years. Thirty years ago, for instance, the model planter kept the ground between his trees as bare as possible; now it is considered essential to preserve the top soil by a copious cover, preferably of leguminous plants. An admirable conspectus of present-day practice was given by Mr. Charles Wright, in his paper, "Modern Aspects of Rubber cultivation," in which he dealt fully with such questions as soil conservation, drainage, tapping systems, manuring and methods of improving strains. The paper was the outcome of five years' close study of the science of rubber growing and experience acquired on the plantations.

"The Lead Acid Cell: Its Place in Modern Industry," was the title of a paper read by Mr. Harold G. Brown. For about seventy years this cell has had an importance of its own, for two reasons: firstly, because, being mechanically and chemically reversible, it could be used to store the energy produced by primary cells, and, secondly, because its internal resistance was so low that enormous currents could be drawn from it without reducing its voltage to insignificance. At the present day its use in industry is very great and is steadily increasing. It is indispensable in small domestic electric plants, and it is largely used in central station batteries. One of its chief individual users is the Post Office, whose total capacity of installations will, it is estimated, increase in the next five years from the present 28,500 k.w. hours to 76,350 k.w. hours. Other important uses of the cell are for the electric lighting of trains, automatic signalling, submarine work, road transport and tunneling and excavation operations; and it will probably remain for many years to come our principal means of storing electrical energy.

In 1894 a course of Cantor Lectures on "Typewriter Machines" was delivered by Mr. Henry C. Jenkins. Since that time a great deal has been done to improve the typewriter, and an account of this development was given by Lieut.-Commander R. T. Gould in a paper entitled "The Modern Typewriter and its probable future Develop-

Abstract Published.

290,421.—Ferric oxide.—Storer, T., 54, Woodstock Road, Moseley, Birmingham, and Taylor, C. J. A., 7, Chetwynd Road, Wolverhampton.

A solution of a ferrous salt to which has been added a non-gaseous oxidising agent such as manganese dioxide, with or without the addition of lime or calcium carbonate, is subjected to heat and pressure, the precipitated ferric oxide after washing and drying being suitable for use as a pigment. *Galvanizers' or Enamellers' waste liquors* neutralised by the addition of scrap iron may be carried out in a steel autoclave fitted with an inner vessel of acid-resisting fire-clay or in an iron autoclave lined with acid-resisting enamel. In an example the reaction is effected at 300° F. in a closed glass tube. The solution of manganese chloride obtained may be treated for recovery of manganese dioxide for further use in the process. In a modification the ferrous salt solution and manganese dioxide are allowed to react as normal temperature, the separated precipitate being then heated under pressure.

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TENDERS.

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FURTHER SPECULATIONS CONCERNING THE NATURE OF LIGHT AND ETHER.

By Dr. W. Tombrock.

In our last essay (*Chem. News*, cxxxvii, 1) we have shown that even in the beginning of physical thought with the ancient Greek philosophers, just as in the present time, two theories as to the nature of light exist side by side but yet opposite to one another, *viz.*—emission : the sending out of material particles from the source of light and visible objects—and undulation : wavelike oscillations in a medium (διαφανες—ether).

We also pointed out that from the very beginning prevailed the staudpoint that—one of the two must be the correct one : emission or undulation—while no account was taken of the third possibiliy, namely, that there could exist side by side the emission : the sending out of light-particles and undulation : disturbances which are propagated in the ether.

For ourselves we have from first principles, the basis of our speculations, arrived at this third and furthermore also obvious possibility that indeed emission and undulation must coexist and indeed the emission must occur primarily and the disturbance set up in the ether and propagating itself therein must occur only secondariiy.

It may probably be of service to repeat once more the argument by which we arrived at this result.

What is matter?

Matter is the substrate of all physics; it is that which moves.

Every movement presupposes something which moves; that somethiug we define as matter and since one must in any case attribute to the ether oscillations, thus movement, the ether is also material. The epithet "immaterial," which one often gives to the ether, simply signifies that the ether evades sensory observation, but the ether must possess movement and thus according to our definition must be material. Otherwise it becomes quite incomprehensible, and cannot serve for the explanation of natural phenomena, which latter we consider as the object of our investigations—the giving of an understandable explanation of material properties and natural phenomena.

Besides our fundamental definition of matter : all that which moves—we also put this property : two material particles cannot simultaneously occupy the same place. One must not lose sight of the fact that this property, however acceptable and obvious it is, is still to be considered as an hypothesis.

As far as the definition of matter is concerned—with regard to this we are quite free and it may be disputed—it is at any rate not illogical. And as concerns the property set beside it, if we were to deny this, we must at the same time put down our object, the understandable explanation of nature, as un-attainable; this property is simply a requirement for an understandable explanation of nature (to wit, that two material particles cannot simultaneously occupy the same place).

With the aid of these two—matter is all that which moves and two material particles cannot simultaneously occupy the same place—we arrive directly at a property of the ether, just as important as it was unexpected in the routine of our thought, namely, that this must consist of small particles... otherwise no motion would indeed be possible in the ether.

Whoever will consider this matter further will see that from this conception—certainly in every respect understandable and as simple as possible—something important also follows directly.

When two material particles cannot simultaneously occupy the same place, an ultimate material particle must then be completely incompressible... while expansion would only be possible by the production of empty space in the material particle which amounts to the splitting up of the particles and on further consideration becomes practically incomprehensible. Very closely connected with the property that two material particles cannot simultaneously occupy the same place and hence the material particle is incompressible is the so-called law of the conservation of matter. This is really the same idea in another form. It is just as difficult for us to imagine that a material particle is produced from nothing or completely disappears as it is for us to try to conceive two material particles simultaneously occupying the same place.

And ,as we have already mentioned, what we can on the contrary quite well imagine is that two material particles might lose the greater part of their motion in a collision and their energy might decrease. The law of the conservation of energy can thus never be put forward as a requirement for an understandable explanation of nature. It is thus of much less consequence than the law of the conservation of matter and as regards this latter, is simply an axiom. It cannot

be proved nor refuted since according to the definition it also applies to the ether and the ultimate material particles among which are included those of the ether are completely beyond our powers of observation... but this axiom of the conservation of matter and the impossibility of the simultaneous occupation of the same place by two material particles is an imperative requirement ,one might say a logical postulate, for an understandable explanation of nature.

We thus see that the ether must consist of particles according to arguments present in our fundamental logical conceptions... what now still follows?

The mean velocity of the etherparticles must be at least that with which light is propagated... about 300,000 kms. per sec. must be considered as a normal velocity among the microcosmical ultimate material particles. The ether-particles are further to be considered—this is also very obvious and may be called "*unsought for*"—to be moving like the particles of a gas. Indeed light and sound show too many analogies for us to think otherwise. *But although* the ether-particle behaves like the particles in a gas, this does not mean that all the gas laws also hold for the ether—still less that, for example, the ether should have a spectrum... A spectrum is an atomic or molecular property and an atom or a molecule *is a combination or complex* of material particles whilst this complex-form is particularly not attributed to the ether. Indeed for this very reason the *ether must* escape our sensory perceptions.

And yet everything points to the essential part of the ether being of the same nature as matter perceptible to the senses. Indeed how otherwise could the amazing action of ether on observable matter and vice versa be explained?

The setting up of a second hypothesis lies ready to hand—*viz.*, that *ether-particles can function* as *electrons.*

We divide the ultimate material particles according to their size and type of motion into three sorts.

Protons—larger particles with considerable rotary and less translatory motion.

Electrons—smaller particles with considerable translation and less rotation.

Ether-Particles—which can function as electrons. The actual bricks of the atom are the *protons* and on account of the considerable rotary motion of the latter we have termed the atom a proton-mill... in which electrons (ether-particles) circulate and from which they are shot out as rotating projectiles. In this way we arrived at surprising explanations of gravitation, electricity, magnetism, and other material phenomena and properties (see "The Atom and Some General Material Properties and Phenomena," *Chem. News*, 1928, cxxxvi, 289).

But let us return to light.

Light-sources on a final analysis are light-giving atoms or protonmills. The latter continuously shoot off the fine material (ether-) particles which are then called electrons. The "food" of the light-sources must be the ether itself. Again and again gaseous moving ether-particles get into the proton-mill in which they lose translatory speed and gain in rotary speed and finally *excite the sensation of light as rotating electrons.* The right-handed or left-handed rotation of the light must be connected with the direction of the rotary motion... but we will not go into this question at the present time.

We thus observce primarily emission in a *light-source.* But now further. Can you imagine that this primary emission, this continuous stream of rotating electrons (ether-particles) can move through the ether-particles lying further away without bringing about disturbances therein?

Well, then, these disturbances, which are then of a secondary nature, must under favourable experimental circumstances produce the impression of undulation. And by *this means the twofold character of light* which had already struck the Greek thinkers and also now causes difficulties to prominent physicists... the emission and propagation is in principle simply and acceptably explained.

To show this clearly we chose the emission and observation of a directed bundle of radio-waves. One can compare this with the wave of sound from a trumpet in an open space. The vibrating air-stream goes straight out from the instrument (to be compared to emission) and perpendicular thereto air disturbances are propagated which also *give* us the *sensation* of sound. In which case in the Marconi-bundle in addition, as we have already remarked, *gravitation,* the *force of suction of* the *proton-mills* of the earth, must play a part.

It is not my intention for the present to work out further the consequences of this theory. My intension was by setting forth reasonable principles to arrive at an understandable explanation or elucidation in a region where in modern times much that is incomprehensible has appeared. I would only remark further that by setting forth

illogical suppositions about the ether one must necessarily arrive at incomprehensible, contradictory consequences.

Ether *must* exist—there is no one who still doubts. And ether is also not space, for space is immaterial, is a pure abstraction, measured distances and this is not ether..., ether is substantial and is not an abstraction, not an imaginary something but, although escaping our observation, still actually something real.

Still less is a complex of properties the same thing as the substance to which they belong. Energy is not substantial, is not mass or matter (unless naturally one will alter the definition of energy already given and acknowledged. But that would be the same as breaking the rules of the game which is assumed to be logical.) Thus ether is not an abstraction, is not space and energy is not matter... the overlooking of these and other simple principles of logic or sound reason (for example, that properties which are produced by a combination of parts do not necessarily belong to the constituent parts separately, etc.) *had* to give rise to incomprehensibilities and even contradictions.

I shall give some examples of the latter in a subsequent article.

Bergen op Zoom,
Holland.
June, 1928.

MORE DIRECT AVENUES TO CHEMICAL TRAINING.

By Robert Saxon, B.Sc., F.C.S. (Lond.), M.A.C.S., M.S.C.I.

(*Continued from Page 52.*)

Electrolytic Acid.

The terms acid, base, and neutral are *merely relative to one another and have no* standard starting point. When two kinds of electricity were called positive and negative it was thought that the conjuring of the former meant the addition of electric fluid to a neutral quantity, and of the latter the subtraction thereof. Yet there was no electric coinage, no scale of electric potential, no zero. This subtle fluid could not be weighed, there was no universal opposition like gravity against which one might pit it and give it a scale. If one charge were greater than another it was not possible to give their ratio. It was possible to say that one behaved towards opposition more quickly or more decisively than the other, but no more could be said. A study of hydrogen ion control reveals the same fact with regard to acidity. We may say that one salt is more acid than another as far as its action with certain indicators is concerned, but we can only place it between two members on a certain list, and further we cannot go. The old definition of an acid had reference to litmus, but alum turns it red. To call a salt an acid because its hydrogen is replaceable by a metal should bring in water or ammonia. There is no compound of hydrogen with as wide a field of action as water. No acid of note acts without it to form salts and the list of compounds which hydrolyse is a long one, yet it is not considered as an acid nor hydroxides as salts, because we have no zero in acidity.

If we drop a crystal of copper sulphate into water it spreads itself out to fill the liquid like a gas. A number of metals may be tried with different parts of a solution which will displace the copper. From the fact that the SO_4 always keeps intact when in solution we might represent the solute state by writing the salt as Cu : SO_4. In the same way water may be written H : OH as the group OH keeps intact in reactions. Magnesium sulphate will be Mg : SO_4 as a solute, and $MgSO_4$ its usual state away from water. The symbol : is used with a ratio, and here it expresses the ratio between the ion atoms and those in the anion in the shape of numbers. Sulphuric acid is written H_2 : SO_4 as solute and an acid salt thereof as KH : SO_4. Electrolysis decides where the : shall go among the symbols. It is well to always in representing electrolysis with formulæ to send the current from right to left on the paper. Then it will drive the ion to the left (the side of the formula it naturally occupies) and the anion to the right. Thus, send the current through water, represent the cathode by the type) and the anode by (. Thus the action of the electrolysis of water might then be represented by—

I. 2H) 2H : OH (2OH, and chemically there follows

II. 2OH = H : OH + O.

This means that when water is submitted to electrolysis the anode attracts the negative OH to be afterwards resolved into water and oxygen, and the cathode the positive hydrogen. This electrolysis of water is the modern way of manufacturing both gases and the International Electrolytic Plant Co. Ltd. have branches for the sale of its apparatus in both the Old World and the New. The introduction to hydrogen and oxygen should be by means of electrolysis. The old method is too slow because the

voltage used is too low. If the lighting current be used instead of a battery with electrodes of stainless steel to give surface sufficient of the gases may be collected to experiment with, in the course of half an hour. At the end of the lesson the water left may be shown to be still water neither acid nor alkaline. The gases may be sparked to produce water blue-turning with white copper sulphate. With chlorate, peroxide, permanganate and sulphuric acid, catalysts, etc., there is a very complicated lot of happenings in the dark, and generally the chief concern of the lecturer is not to show the character of the residue but to get his apparatus clean, especially in the case of permanganate. By electrolysis of saturated solutions it is possible to show the production of chlorine, bromine, iodine, carbon dioxide, carbon monoxide (oxidation of a carbon anode), sulphur dioxide, and the oxides of nitrogen, as well as any of the common acids and a host of hydroxides. Indeed electrolysis is now a recognised commercial method of producing hydroxides.

Submit copper sulphate to electrolysis with voltage between 100 and 150 from lighting line and note—

I. Appearance of flocculent blue substance round cathode which if removed and dried blackens to form copper oxide. This is the *light blue hydrate* of copper.

II. Acidification of the electrolyte as evidenced by an indicator. *Sulphuric acid* is produced.

III. After a time *copper* is deposited which viewed through the blue solute cuprion appears *like silver* though actually red. At this period of the reaction the acid is produced rapidly and at the end of an hour the liquid given abundant precipitate with barium chloride, and calcined after evaporation on sugar will blacken it in less time than would be the case if plain water were used. Here we have a simple method of producing sulphuric acid from any sulphate. With a base of more positive electrochemical character than copper the hydroxide is produced instead of the metal. Using green vitriol we get the acid and red hydroxide of iron after the green. These reactions may be represented as with copper and iron sulphates as follows) being the cathode negative and (the positive anode, substances between these symbols ionised and those outside as delivered and sensitive to chemical reaction. Chemical action is reversed by the current therefore chemical equations are out of place between the symbols) and (. (Instead of the + as used in equations the symbol / is adopted as it takes up one-third the type space taken up by the +)

I. H_2) 2H : OH / Cu : SO_4 / 2H : OH (H : OH / O

II. $Cu(OH)_2$ and H_2SO_4 are produced in defiance of chemical action which would produce copper sulphate.

III. As the production of hydrogen dies out copper appears thus

Cu) $CuSO_4$ / 2H : OH (H : OH / O

producing sulphuric acid in the electrolyte and delivering copper water and oxygen outside the electric stream. We might have written the mixture of copper sulphate and water thus—

Cu : SO_4 : 2H : 2OH

showing four centres of attraction the Cu being as ready to unite with the OH as the SO_4, which has the same freedom with regard to the Cu or the 2H, but it is preferable to separate compounds taken for the reaction by the symbol /. It should be noted that this is used for ratios as a/b is the same as a : b. With green vitriol we have the follolwing taking place—

H_2) 2H :OH / Fe :SO_4 / 2H :OH (H :OH / O

giving Fe $(OH)_2$ / H_2SO_4 later the hydroxide becoming ferric. The magnesium sulphate results in similar products as ferrous iron. The hydroxide may be collected and dissolved in the acid and crystallised.

This sign of ionisation is very helpful to beginners. It separates group and group or base and acid radicle facilitating the writing of equations. It does not separate compound from compound but the symbol which takes its place therefor has a similar fractional signification. Thus a mixture of barium chloride and silver nitrate result in the production of a precipitate. The fact that such has no sign : shows it to be insoluble thus—

Ba : Cl_2 / 2Ag : NO_3 = Ba : $(NO_3)_2$ / 2AgCl

We may point out that we begin with Ba, Cl, Ag and NO_3 all free to make new alliances, and the insolute character of AgCl decided the matter. Note that the ratio between the molecules is 1/2 and the notation says so. The electrolysis of such compounds as potassium ferrocyanide yields no hydroxide and furnishes a reason for writing the formula K_4 : $Fe(CN)_6$, although potassium cyanide would be K : CN. We may point out that in $CuSO_4$ Cu is not blue as in Cu : SO_4, that Fe is green in Fe : SO_4, but not so in the ferrocyanide, and so on. Water chosen as electrolyte needs no acid to start if the lighting current be used. Various metals may be used as anode and for metals above hydrogen in the electromotive list the hydroxide results. Some metals like tungsten give the oxide only, and

this metal gives beautiful colour effects corresponding to the colour of its oxides. If a porous pot be used, a mercury cathode inside it, and a very concentrated solute, an amalgam forms which dropped into water liberates hydrogen in the case of the alkalis and earths. Petroleum may be used to cover up the cathode which glows as the metal unites with it to prevent oxidation. In electrolysing water it behaves exactly like an acid its radicle being hydroxyl OH.

Diffusion and Fractional Crystallisation.

Make up and explain decimolar solutions of copper sulphate and sodium nitrate, a well-known salt. Pour gently down the side the copper sulphate on to the nitrate. In another repeat but put the copper sulphate at the bottom. Note—

I. Copper ions bombard their envelope like a gas and diffuse throughout the whole liquid. The only thing which they cannot break through is the surface tension, for evaporation leaves them behind. Kinetic energy is less than the surface tension.

II. Gravity assists diffusion, so that these ions must have weight.

III. Diffusion takes place in spite of gravity, and incidentally the difference in the energy manifested in the two rates will give an indication of the energy due to gravity less friction.

Evaporate the mixture and note—

I. The colour deepens as evaporation proceeds, and then lightens as copper sulpbate is deposited.

II. With first crop there are few or no crystals of sodium nitrate.

Repeat the process with the liquid that is left. Redissolve in as little water as possible then drop the tempeṙature at each stage until the two salts are separated. Repeat with magnesium sulphate and sodium nitrate, then with the two sulphates, and explain failure in the last case to separate. Writing a mixture thus—

$$Mg : Cl_2 / Cu : SO_4$$

we may say to ourselves "Here are four centres of attraction dancing, gliding, and swinging round each other, and the Mg does not mind which it takes the Cl or the SO_4. If we cool our solution saturated at say 80 degrees down, which salt will result." We must then consult the Dictionary of Solubilities to see which is less soluble at say 60 $MgCl_3$ or $MgSO_4$ and that will come down as here written in the solid state.

These are a few of the laws of chemistry which we can evolve round familiar substances without leaving behind a mass of mystery. In preparing hydrogen in the ordinary way the student cannot see where the hydrogen comes from, and is juggling with metal acid water and salt. With oxygen he cannot for the life of him understand why the manganese dioxide loses no weight, and still is used, and his trainer cannot enlighten him. He learns how simple is the explanation of the action of the three ingredients in the making of chlorine. Later he learns how difficult it is to say with certainty what actually does take place. He does not realise that one reaction in a series does not await the completion of another but that both are simultaneous. The book does not say this. It does not emphasise sufficiently the existence of electro-chemical attractions working together in mixtures, in many cases forming no intermediate compounds hut by united sway bringing about the result.

However, this is submitted as a suggestion that the student be introduced to the elements and elementary laws of chemistry from concrete clear illustrations got from the everyday world about him, instead of landing him into the world of chemistry in a series of attempts made futile by fog. He will remember his laws because he has something upon which to hang them. He will visualise their working because he is familiar with their subjects.

In the *Journal of Chemical Education*, Feb, 1928, Messrs. Meldrum and Forbes have said: "It is highly desirable because of the student's inexperience that the procedure be simple and straightforward and that he may obtain results that do check without too many repetitions. Repetition of analyses in the first few weeks of the course may be counted upon, as a rule, to kill interest pretty effectively." If he be made to realise the aim of scientific researcb he will not mind any amount of drudgery, especially if he play the part of detective following a series of more or less obscure trails left by the feet of those seeking the abode of everlasting truth. There will then be no need of providing against such states of affairs as suggested in the following extracts from the same journal, a state obtaining almost everywhere where examiners ask for nothing else in answer to their questions but empirical data.—"Until training in honesty is provided in the primary grades we cannot expect it to exist among students in the higher schools."—Fenton. "It is estimated that a Ph.D., from Harvard is worth in the neighbourhood of 30,000 dollars."—Harvard Alumni Bull. This last needs no comment, except that it is the primary cause of the first extract.

THE WIDER ASPECTS OF COSMOGONY.

By J. H. JEANS, M.A., D.Sc., LL.D., F.R.S., Secretary of the Royal Society.

(Before the Royal Society of Arts, Trueman Wood Lecture, 7 March, 1928, Sir Frank Watson Dyson, K.B.E., LL.D., D.Sc., F.R.S., Astronomer Royal, in the Chair.)

Interest in scientific cosmogony is a recent, and still a very tender growth. Anthropologists and geologists tell us that man has existed on earth for something like 300,000 years; we must go this far back to meet our ape-like ancestry. Between them and us some 10,000 generations of men have walked the Earth(most of whom have probably given some thought, in varying degrees, to the significance of their existence and the plan of the universe.

But of these 10,000 generations of men, the first 9990 unhesitatingly regarded the earth as the centre, and terrestrial life as the central fact, of the universe. As was suited to its majesty and dignity as the abode of man, the earth stood still while the celestial sphere spun round it, covering in the earth much as a telescope-dome covers in the telescope. And this dome was spangled with stars, which had been thoughtfully added so as not to leave the central earth unillumined at night. Ten generations at most have been able to consider the problem of their existence in anything like its proper astronomical perspective.

The total age of the earth far exceeds the 300,000 years or so of man's existence. The evidence of geology and of radio-activity in rocks in particular, shows that it must be something like 2,000 million years, which is several thousand times the age of the human race. Old Mother Earth must regard man as a very recent apparition indeed; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features. If he has done so much in the first few moments of his existence, she may well wonder what is in store for her in the long future ages in which he is destined to labour on her surface. For in all probability the life in front of the human race must enormously exceed the short life behind it. A million million years hence, so far as we can foresee, the sun will probably be much as now, and the earth will be revolving round it much as now. The year will be a little longer, and the climate quite a lot colder, while the rich accumulated stores of coal, oil and forest will have long been burnt up; but there is no reason why our descendants should not still people the earth. Perhaps it may be unable to support so large a population as now, and perhaps fewer will desire to live on it. On the other hand, mankind, being three million times as old as now, may—if the conjecture does not distress our pessimists too much—be three million times as wise.

Looked at on the astronomical time-scale ,humanity is at the very beginning of its existence—a new-born babe, with all the unexplored potentialities of babyhood. And until just now, its interest has been centred, absolutely and exclusively, on its cradle and feeding bottle. It has this moment become conscious of the vast world existing outside itself and its cradle; it is learning to focus its eyes on distant objects ,and its awakening brain is beginning to wonder, in a vague, dreamy way, what they are and what purpose they serve. Its interest in this external world is not much developed yet so that the main part of its faculties are still engrossed with the cradle and feeding bottle, but a little corner of its brain is beginning to wonder.

Taking a very gloomy view of the future of the human race ,let us suppose that it can only expect to survive for two thousand million years longer, a period about equal to the past age of the earth. Then, regarded as a being destined to live for threescore years and ten, humanity, although it has been born in a house seventy years old, is itself only three days old. But only in the last few minutes has it become conscious that the whole world does not centre round its cradle and its trappings, and only in the last few ticks of the clock has any adequate conception of the size of the external world dawned upon it.

For our clock does not tick seconds, but years. A minute and a half ago the distance of a star was first measured and provided a measuring-rod for the universe. Ten seconds ago Shapley showed how the peculiar stars known as Cepheid variables provided a longer measuring-rod, and taught us to think in distances so great that light takes hundreds of thousands of years to traverse them. And, with the very last tick of the clock, Hubble, using the same measuring-rod, has found that the remote objects visible in the biggest telescope on earth are so distant that light, travelling 186,000 miles a second, takes about 140 million years to come from them to us.

Not only is our vision of the universe continually expanding, but it is expanding at an ever increasing rate. Is this expansion

destined to go on for ever? So far as we can at present see, no; for a general guiding principle, that of generalised relativity, fixes a limit, which we are fast approaching. According to this theory, space cannot extend for ever; it has no limit, but is never-the less finite like the surface of the earth. Without exploring and surveying the whole of the earths' surface, we can make a fair estimate of its total area by measuring its radius, which we can do by measuring its curvature at any one poin. In the same way the total volume of space is fixed by a quantity, the curvature of space, which can be determined by measuring the density of distribution of matter in space.

Exact figures are impossible, but Hubble has calculated that space is not likely to extend to more than about a thousand times as far as the furthest nebula visible in the biggest telescope. Nothing prevents our going on and on in space beyond this distance, but, if we do, we merely come back to ourselves. The possessor of a sufficiently sensitive wireless apparatus may emit signals and pick them up a seventh of a second later after they have travelled round the world. In the same way a not inconceivable increase in the size of our telescopes would take us round the whole of space, and we should see the stars surrounding our sun by light which had travelled round the universe, not of course as they now are, but as they were 100,000 million years ago.

Such considerations make it improbable that the expansion of the universe can continue at its present rate for much longer. Having grasped that the world is round, the infant speedily forms a fair idea of its size. Our particular infant, mankind, has made the great discovery of the existence of the outer world, has formed some conception of its size, and adjusted his ideas, not by a process of slow revelation, but by a brain-flash of the last few seconds. In his mature years and his staid old age he is no doubt destined to make many sensational discoveries, but he can never again live through the immortal moment at which he first grasped the immensity of the outer world. You and I only live through a few ticks of his clock, and fate might have ordained that they should be anywhere in the three days that the child has already lived, or in the seventy long, and possibly tedious, years yet to come. The wonderful thing is that she has selected for us what is perhaps in some ways the most sensational moment of all in the life of our race.

The child sets its newly-awakened mind to work to adjust and co-ordinate a new array of facts. If the world wasn't made to surround its cradle, what purpose can it serve? If the lights of the great ships in the harbour were not designed to light its nursery at night, what can they possibly be for? And, most interesting problem of all, fi the world is such a big affair ,can there be other cradles and other babies?

These remarks will have served their purpose if they suggest to you that what I am rashly trying to put before you should not be judged as a finished science or the solution of a problem; it is rather the first confused gropings of the infant mind trying to understand the world outside its cradle. And if the impression produced by its first inexperienced glance at the outer world had to he described in a single word, it would probably select the word " immensity."

The immensity of space is measured by the figures already mentioned. Light and wireless signals travel at the same rate because, of course, they are essentially the same thing. And this thing takes a seventh of a second to travel round the world, and probably something like 100,000 million years to travel round the universe. The ratio of these times (2×10^{19}) measures the dimensions of the universe in terms of the familiar dimensions of the world; incidentally it also measures the expansion of our spatial ideas since Copernicus. The disparity of size is too great to be easily visualised. Suppose the size of our earth represented by a single atom a hundred millionth of an inch in diameter, then the range of vision of the biggest telescope is about represented by the whole earth, and the size of the whole universe, accordng to the theory of relativity, is represented by a stack of a thousand million earths.

Hardly less bewildering than the immensity of space is the immense amount and variety of matter it contains. The sun, which is a million times as big as the earth and 300,000 times as massive, proves to be something less than a grain of sand on the seashore. It forms one of a family whose number must certainly be counted in thousands of millilons; Seares has estimated it at thirty thousand millions. This is not the only family of stars in space. Each of the great nebulæ is either a family of stars, or consists of stars in the making, or of matter which is destined ultimately to form stars. We can estimate the masses of these great nebulæ by gravitational means, and each is found to contain enough matter to make a thousand million suns. This of itself will give some conception of the vast size of these nebulæ, but to tell the whole

story, it must be added that their colossal masses are so tenuous that each millionth part of an ounce is, on the average, as big as the Matterhorn. Think of a body which is bigger than the Matterhorn by as much as a thousand million suns is heavier than a millionth part of an ounce, and you have the size of any one of these great nebulæ.

Hubble estimates that about two million such nebulæ are visible in the great 100 inch telescope at Mount Wilson ,and that the whole universe has about a thousand million times the volume of that space visible in this telescope. Let us now multiply 1,000 million by 2 million, and the product by 1,000 million. The answer (2×10^{24}) gives some indication of the number of stars in the universe; the same number of grains of sand spread over England would make a layer hundreds of yards in depth. Let us reflect that our earth is one millionth part of one such grain of sand, and our mundane affairs, our troubles and our achievements, begin to appear in their correct proportion to the universe as a whole.

(*To be Continued.*)

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

The Twelfth Annual General Meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1., on Thursday, 12 July, 1928.

Report and Accounts.

The Chairman (Mr. C. A. Hill in moving the adoption of the report, said :—

" I would like, at the very outset, to refer to the great pleasure which I am sure all members of the Association feel in regard to the recent elevation of the Vice-Chairman (Sir Alfred Mond), now Lord Melchett, to the Peerage. The honour which has been bestowed upon him is a well-deserved recognition of the invaluable services which he has rendered to the country generally and, in particular, to the Chemical Industry.

A new issue of the Directory of the Association will be brought out at the beginning of 1929, and the Council is most anxious that it should not only be up to the high standard of previous issues but that it should be, if possible, better. There is a real demand for the Directory both at home and abroad, and I feel that some members do not perhaps realise the wide publicity which it affords. As an advertising medium it should be of very great value and I would urge all members, who have not already done so. to use it for advertising purposes. of the Directory as representing the products of the Association be considerably enhanced, but financial benefit would accrue to the Association itself.

I would now like to say a few words on the subject of Exhibitions. We all feel that Exhibitions can be overdone. The considered view of the Council is that it is inadvisable to patronise more than one Exhibition a year and that everything possible should be done to make that one Exhibition really representative of Chemical Industry. The Council feel that the Exhibition which the Association should support should be the British Industries Fair, and we hope it will be possible to fill the whole of the allotted space with exhibits from this Association and from the British Chemical Plant Manufacturers' Association, who we hope will again join up. We want to make the Section not only once more worthy of our Chemical Industry, but also one which will bear comparison with the Chemical exhibits in any other country.

Reference is made in the Report to the pamphlet on those portions of the Rating and Valuation Act,1925, which are likely to affect chemical industrialists. It is certain that in the application of this Act many doubtful cases are likely to arise in view of the varied nature of the machinery and plant used in the industry. It is very desirable in the interests of us all that details of such doubtful cases should be reported to the Association so that members generally may be kept " au fait " with the decisions which are reached in different parts of the country by the Panel of Referees. There is an undoubted necessity for co-ordination and co-operation to ensure the uniform application of the Act throughout the country, and it is particularly important that the decisions of the Referees should be carefully watched, so that basic principles should not be laid down for particular cases without full consideration of their bearing on Chemical Industry as a whole.

The tariff situation is still one of considerable interest. The recommendations of the Economic Conference at Geneva last year have had a beneficial effect on restricting the imposition of new tariffs, and have in some cases actually produced a reduction of them in the trading agreements between various countries. The future work of the Economic Consultative Committee will require to be carefully watched when chemical products are under discussion, as this is a matter which affects this Association very

I should like to say a few words about the work which the Resistant Metals Committee is doing. The Chemical Industry is in great need of new materials for the construction of plants which deal with corrosive substances, and the production of suitable metals to meet these requirements would result in considerable financial advantage to the industry. The reorganised Resistant Metals Committee, which represents the makers of the resistant metals, the manufacturers of chemical plant and the users of the plant, combines all the elements necessary for a concentrated and co-ordinated attack on the problems involved. This kind of co-operation is of first-rate importance and it is the aim of the Council to encourage it for the study of problems affecting many interests.

With the object of the new budget duty, namely, the relief of depressed industries, we are all in agreement, but there has been considerable complaint in regard to the incidence of the duty on oils used as raw materials or ingredients for manufacturing processes, as this is a tax on instruments of production which, according to the Chancellor of the Exchequer himself, should not be taxed.

As regards the rating relief which we are to obtain in another eighteen months' time, I understand that the relief to the Chemical Industry as a whole will be about £600,000. In case any of you may be under a misapprehension regarding the scope of the rating relief, I would draw your attention to the fact that from our interpretation of the proposed Rating and Valuation (Apportionment) Bill, 1928, it would appear that the relief will apply only in respect of actual productive buildings with an allowance of 10 per cent. for other buildings not used in actual production. Since many chemical manufacturers have a large proportion of storage accommodation, they may find that this rating relief is lower than they had anticipated.

The first chemical case with which the Tribunal with its K.C. Chairman and two scientific assessors has dealt, has been in respect of Calcium Biphosphate. This substance was originally included in the list of dutiable articles but was removed, together with other chemicals, by the Board of Trade in the light of decisions given by the Referee, by whom cases were decided before the present Tribunal was constituted. (Calcium biphosphate (Baking powder quality) has now been restored to the dutiable list by the Tribunal, and this constitutes a very important decision.

I have already indicated to you a number of questions with which the Association will have to concern itself in the near future. Others will certainly arise. The Association has proved its value to the Chemical Industry in the past and I am sure its services will be equally required in the future. There are still many outstanding problems of great importance ahead of us; I need only refer to the fact that the Dyestuffs (Import Regulation) Act will expire in 1930, *i.e.*, in two years time, while in eight years the present Safeguarding of Industries Act will have run its allotted period. The expiration of these measures will entail the consideration of problems of vital significance to the Industry, and will call for concentrated efforts and the ntmost co-operation from all Members of the Association.

I wish to refer to the changes which have taken place in the staff of the Association. The news of Mr. Woolcock's proposed resignation from the post of General Manager and Secretary was, I am sure, received by all members of the Association with as great regret as it was by the Council. Mr. Woolcock has been with us so long that we had all come to regard him as a pillar on which the Association relied for a great deal. It is quite unnecessary for me at a meeting of this sort to say how much the Chemical Industry of this Country owes to Mr. Woolcock for you all know it as well as I do. I need only mention the conspicuous part he has played in connection with those two very important protective measures, *viz.*, the Dyestuffs Licensing Act and the Safeguarding of Industries Act. I am sure you will all be pleased to hear that Mr. Woolcock is continuing his membership of the Dyestuffs Licensing Committee and of the Dyestuffs Development Committee of which he has for so long acted as Chairman with conspicuous success. We all wish him the utmost success in his new sphere of activity.

The position created by Mr. Woolcock's resignation was carefully considered in all its aspects and it was decided to appoint Mr. Davidson Pratt to the post of General Manager. Mr. Davidson Pratt was, I believe, already known to many of you, since he has been associated with the Chemical Warfare Research organisation of the Fighting Services for the past twelve years, and for the last five years has been head of the Chemical Warfare Research Department.

I here wish to express our appreciation of the generous action of the Fighting Services in allowing Mr. Davidson Pratt to begin his

new duties at very short notice. This was done on the understanding that Mr. Pratt should be allowed to devote a progressively decreasing part of his time to his old post until the question of his successor had been settled. I understand that his successor has now been nominated so that Mr. Pratt will shortly be free from the dual burden which he has had to carry during the past two and a half months. It is hardly necessary for me to ask you to accord him the same full measure of help and support as you have ever given to his predecessor.

On making the new appointment of General Manager, the Council decided to recognise the devoted service which Miss Small has rendered for the past six years by appointing her Secretary. I am sure all of you who know Miss Small will heartily endorse this action."

(To be continued next week.)

GENERAL NOTES.

CITY HEALTH OFFICER'S WARNING.

" The gas industry has been an enormous factor in reducing the smoke evil of great cities," declared Dr. S. G. Moore, Medical Officer of Health for Huddersfield, in an address on " Smoke Abatement " at the Royal Sanitary Congress, Plymouth, on Friday, July 20.

" Reputable British makers," he said, " had caused prolonged scientific researches to be made into the whole question of gas heating, and the results were seen to-day in serviceable, scientifically-constructed equipment that could be safely used without the slightest detrimental effects to health. The good modern gas fire heated adequately and assisted in healthful ventilation, and for these reasons it must be given an important place in the heating arrangements of new housing schemes.

" Municipal housing authorities and builders had come to see in gas a powerful ally in the campaign against smoke, and were making plentiful use of it. Gas stoves were now regularly used in the kitchens of most houses in the land. This development alone had made a great difference. He asked them to imagine if they could, what the effect would be if this change had not taken place, and ,say, on a Sunday morning, 10,000,000 coal ranges were simultaneously cooking the Sunday dinner, causing 10,000,000 kitchen chimneys to belch forth dense volumes of black smoke. They would then have a very good idea of what domestic smoke could really achieve in the way of nuisances."

Dealing with the all-gas and all-electric house, Dr. Moore said it was desirable to point out in the case of the latter type of structure the undesirable practice that had crept in of omitting flues from the rooms.

" In this country," he declared, " an air channel of adequate dimensions from near the floor to the roof top is the normal means of ventilation in the rooms of houses, and, whatever the system of heating provided, one should be allowed for in every apartment designed for human occupation. The grid or air brick is not sufficient to ensure properly hygienic conditions when free ventilation does not exist, while the earthenware pipe of small dimensions and such like are worse than useless."

PULVERISED FUEL FOR METROPOLITAN POWER STATION.

The Metropolitan Railway Company has now placed an order for the remodelling of their exsting boiler plant at Neasden Power Station. The plant at present consists of 20 boilers, stoker fired, and the new order, which has been placed with International Combustion, Ltd., will replace these by 6 boilers of the vertical bent tube Lopulco type, fired by the company's bin and feeder system of pulverised fuel firing. The new plant will embody the contractor's latest features in pulverised fuel installations, including drying the raw coal during its progress through the grinding mill circuit.

For grinding, 6 pulverising mills, each of 6 tons capacity (1 per boiler) will be installed. Two of the latest " R " burners per boiler will be used, and the combustion chamber will be lined with Murray fin tubes on three sides, no cooling being used on the front wall where the burners are installed. No economisers will be used, but the air will be preheated with the Underfeed Stoker Company's air heaters superimposed. The flue gas temperature at the exit will be 270° F., and the air temperature on leaving the air heaters will be approximately 500° F.

With respect to the boilers, these will be operated at a pressure of 300 lbs. per sq. in. with a normal evaporation of 80,000 per hour, and a maximum of 100,000 per hour, the total temperature being 750° F. The heating surface of each boiler will be 9,050 sq. feet., the heating surface in each combustion chamber being 950 sq. feet of exposed surface. The feed water temperature will be approximately 250° F.

In addition to the boilers, air heaters and pulverising equipment mentioned above, the plant will also include raw-coal handling equipment and ash handling plant of the sluice type, both by Underfeed Stoker Company, instruments, piping, dust collectors, induced and forced draught fans, with two motors per fan, andother accessories. The complete buildings are included in the contract, but the foundations will be supplied by the clients. The approximate cost of the complete order is £210,000.

PHOSPHORIC ACID PASTE WANTED FOR CANADA.

His Majesty's Senior Trade Commissioner in Canada (Mr. F. W. Field) reports that an important Montreal firm is desirous of being placed in touch with United Kingdom manufacturers of phosphoric acid paste, 48-50 per cent., in five ton lots.

United Kingdom manufacturers of phosphoric acid paste can obtain further particulars of this enquiry on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference number BX. 4593 should be quoted.

MARKET FOR CHEMICALS IN CHILE.

A confidential report on the market for chemicals in Chile has been prepared by the Department of Overseas Trade from information furnished by the Commercial Secretary at Santiago (Mr. W. F. Vaughan Scott), and issued to firms whose names are entered on its Special Register.

United Kingdom firms desirous of receiving a copy of this report, together with particulars of the Special Register service of information and form of application for registration, should communicate with the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference No. BX. 4538 should be quoted.

BRITISH POST OFFICE RECEIPTS.

The average daily receipts from postal traffic in 1924 was £114,618, 1925 £118,888, 1926 £118,632, 1927 £125,516, while for the first six months of 1928 there has been a substantial increase.

COPPER AND NICKEL-COPPER MINES IN CANADA.

The Mines Branch of the Dominion Department of Mines at Ottawa has just issued a revised edition of List No. 2-3, "Copper and Nickel-Copper Mines in Canada," showing the Companies operating in the various mining districts of Quebec,

Copies of the List in question can be obtained on application either to the Department of Mines at Ottawafi or to the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

NEW SMELTER FOR INTERNATIONAL NICKEL COMPANY.

The International Nickel Company has completed arrangements for the erection of the new smelter at Copper Cliff, near Sudbury, Ontario, which will be used in the treatment of nickel-copper ores from the great Frood Mine.

While details of the proposed construction programme have not been announced, the general belief is that the smelter will be one of the largest ever erected in Canada. The presene schedule provides for completion before the Frood Mine is brought into production in 1931. Ground will be broken on the site of the smelter towards the end of the present summer or early in the autumn.

HEAT WAVE FUEL RECORD.

During the heat wave the demand for coalite, the residual fuel of low temperature carbonisation, has increased to such an extent that it has become necessary to open up another battery of retorts at the Low Temperature Carbonisation Company's Works at Barugh, Yorkshire, in order to meet the demand. Normally, of course, sales of fuel are at their lowest poiut at this time of the year.

This fact is pointed out by Lt.-Col. W. A. Bristow, Managing Director of the Company, in a circular, issued this week-end to shareholders in order to refute the insinuation made on behalf of certain foreign concerns that no process in this country has yet been established on a commercial basis. It is anticipated, says the circular, that during next winter the demand will be greatly in excess of the present output, and until the new works which are to be erected at Askern, Yorkshire, and iu London, are completed, smokeless fuel will be over-sold.

The cost of conversion of the slack coal into smokeless fuel and its by-products has been reduced to well below 5s. per ton. The new Barnsley plant has now been in operation for twelve months, days and night, and during that period fifty thousands of small coal has been distilled, yielding approximately thirty-five thousand tons of coalite, one million gallons of coal oil and motor

ACID RESISTING MATERIALS.

A Russian inventor, Mr. Albert Flexer, has obtained an acid-resisting product which is manufactured by Messrs. Watproof, of 16, Rue de Bretagne, Asnieres, France, under the name "Contracite." "Contracite" has already been introduced into a number of important chemical works with considerable saving on wear and tear of construction materials.

Further trials having been successful, it has been possible to put on the market a cloth, "Kautshit," which also possesses these acid resisting properties. It is made in different thicknesses according to the need, *e.g.*, as wall covering or for floors or ceilings of factories and laboratories. It costs about four shillings a square yard. It not only withstands the action of dilute acids but even those of high concentration. "Kautshit" can be used up to temperatures of 280° F., and is available in qualities of different rigidity.

LARGEST STEEL PLANT IN EUROPE.

The huge German syndicate of coal and steel producers known as the United Steel Works Corporation will this year complete the construction of additional units to its works at Hamborn, bringing their capacity up to 2,500,000 tons of raw steel annually, and making this plant the largest in Europe.

One of the most important steps in the construction of the Hamborn plant has been the installation of two large cokeries for the supply of fuel to the works, the coke-coal for the cokeries being supplied from the Corporation's mines. The United Steel Works are now both the largest producer and largest consumer of coke in Europe, their production amounting in the last business year to 8,204,878 tons.

A feature of the economic methods at which Germany is aiming is the utilisation for commercial purposes of the waste gas produced by the Steelworks' cokeries. Apart from the production of approximately 3,000 million cubic metres of surplus flue gas, now used for the heating of the cokery ovens, the United Steel Works produce annually 2,500 million cubic metres waste coke-oven gas—an amount equal to five times the requirements of the City of Berlin. Of this, 2,000 million cubic metres are consumed by the Corporation's own works, leaving 500 million cubic metres surplus gas.

Instead of constituting a dead loss to the company this surplus coke-oven gas is now formed companies, in both of which the United Steel Works, in association with the U.S. banking firm of Dillon Read and Co., has a controlling interest. The first of these, the Ruhr Gas Corporation, has undertaken the supply of far-distant cities such as Hamburg and Hanover with Ruhr gas, brought from the source of production in pipe-lines many hundreds of miles long. In addition, all means of utilising waste cokery gas by chemical processes, particularly that of ammonia synthesis, are being investigated by the second of these two subsidiary enterprises, the Ruhr Chemicals Corporation. This company is particularly occupied with the production of synthetic fertilisers from coke-oven gas, and the first plant at Holten near the Rhine, now in course of construction, is equipped to produce 20,000 tons of nitrates annually.

BOARD OF TRADE ANNOUNCEMENT.

Zirconium.

Representations have been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding zirconium oxide.

Section 10 (5) of the Finance Act, 1926, is as follows:

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any communications with respect to these representations should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

CHEMICAL SOCIETY'S LIBRARY.

The Library of the Chemical Society will be closed for stocktaking from Monday, August 6, until Saturday, August 18, inclusive, and will close each evening at

WELDING OF HIGH-CHROMIUM ALLOYS.

Welding processes suitable for the various groups of chromium-iron alloys are dealt with in a paper recently published by the *American Welding Society*. The author gives data on experiments carried out on three typical series of alloys of the following compositions :—

	1	2	3	
Carbon	0.11	0.08	0.12	%
Manganese ...	0.33	0.29	0.32	
Silicon	0.39	1.05	0.13	
Chromium ...	12.30	17.21	17.42	
Nickel	—	—	7.58	

The results indicate that welds in rustless irons of either type 1 or 2 are brittle and void of any appreciable ductility in the " as welded " condition, but considerable toughness may be imparted to them by annealing at a dull red heat for 5-15 minutes, followed by air cooling.

Welds in rustless iron containing chromium 16-18, nickel 7-12 per cent. are ductile and require no after treatment. In the " as lweded " condition, a yield point of 50,000-60,000 p.s.i. (22-27 tons per sq. in.) and ultimate tensile strength of 65,000-75,000 p.s.i. (29-33 tons per sq. in.) are obtained, with elongation of about 15 per cent. on 2 inches over the weld, and the material may be bent through an angle of 140-180 degrees, nidicating a high degree of ductility.

Single Vee welds in ⅛ in. thick material of this type have been made showing an ultimate tensile strength of 80,000 p.s.i. (36 tons per sq. in.) with 32 per cent. elongation on 2 inches over the weld. Since welds in these nickel-containing alloys show the best combination of strength and ductility in both the " as welded " and the annealed conditions, it is considered the best alloy to use for welded construction. The properties obtainable are dependent to a considerable extent on the quality of the metal and its physical properties before welding, *e.g.*, moderately cold worked light gauge sheet usually yields higher weld strengths than fully annealed material.

Although a suitable flux (the use of which is an important point in welding these alloys) will readily dissolve the chromium and iron oxides, it is recommended that all surfaces welded be clean and free from oxide and mil lscale : due regard must also be paid to the most suitable conditions of heat-treatment, etc., for the material being used if the optimum properties are to be obtained in the welds.—W. B. Miller : "Welding Corrosion Resisting Steel Alloys."—([illegible] American Welding Society, May.

WONDERS OF SURGICAL SCIENCE.

The most modern equipment employed in the various branches of the medical and surgical sciences were shown at an Exhibition held at Cardiff from 23 to 27 July, in connection with the annual meeting of the British Medical Association.

The exhibits included curative apparatus of a new and wonderful character used in hospitals, surgical appliances of all kinds for the treatment and use of indoor and outdoor patients, drugs, invalid foods and beverages, and a wide range of articles demonstrating the latest developments of hygiene and sanitation.

A large stand in the latter section was devoted entirely to gas cooking and heating equipment representing the prolonged experimental and research work carried out in the laboratories of some of the leading British makers. These will include self-ventilating gas grates of the injector ventilator pattern, supplied by Radiation, Ltd., constructed with an extra outlet to effect a sufficient change of air to promote healthy conditions and prevent draughts in an occupied room. Regulo-controlled " New World ' Cookers, made by the same firm, were also shown. These appliances ensure the perfect cooking of dishes and, if need be, whole meals, within a given time without supervision.

New gas-heated apparatus for dental and other purposes were also exhibited.

NOTICES OF BOOKS.

The Chemist's Year Book, 1928. Edited by F. W. Atock, M.Sc.Tech., D.Sc. (Man.) B.Sc.(London), Fellow of the Institute of Chemistry, assisted by R. T. Elworthy, Ph.D(Lond.), F.I.C., Technical Director, Industrial Processes Development, Ltd. Pp. 1,174, and Index. Price 21s. Manchester : Sherratt and Hughes, 34, Cross Street.

There is no need to praise this excellent work, which contains a mass of information of great interest to the chemist. There is a useful summary of the contents at the beginning of the work and a detailed index at the end, so that little difficulty is experienced in referring to any of the thousands of facts and figures contained in the work. The book should find a place in the library of every chemist and in fact every scientific man.

The Extra Pharmacopœa. Vol I. 1928.

Harrison Martindale, Ph.D., Ph.Ch., F.C.S. Nineteenth Edition. Pp. xxxvi + 1,207. Several illustrations. F'cap 8vo. Price 27s. 6d. net. London: H. K. Lewis & Co., Ltd., 136, Gower Street, and 24, Gower Place, W.C.1.

Arranged in alphabetical order this book can be consulted with pleasure and any of the large mass of information located without conference with index. The work has been carefully revised, and thus the various new advances in science have been embodied. We note that the work was begun some 45 years ago as a small unpretentious volume, but has now outgrown the single volume convenience, and is issued in two portly volumes.

Atomic Structure as Modified by Oxidation and Reduction. By William Colebrook Reynolds, D.Sc.(Lond.), F.I.C., A.R.C.S. Pp. viii + 128, with diagrams and folding table. Price 7s. 6d. net. London: Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C.4.

In this useful volume are recorded the results of the investigation of the processes of oxidation and reduction, the editor being critical of the hypotheses and theories of other writers. Attention is also directed to the association of the electrons in defined groups. The oxidation and reduction of inorganic and organic substances are succintly dealt with. The nature of chromophores, the emission and absorption of radiation, the structure of solid conductors and magnets are dealt with under respective chapters, while one chapter is devoted to electrons, protons and ether. The book is carefully written, and the various chapters arranged to the best advantage, the convenience of the reader having apparently been carefully considered.

BATH MINERAL WATERS.

The scientific investigation of the Bath mineral waters has been lately engaging the attention of the Baths Committee, who in their quarterly report to the City Council referred to the pains-taking investigations of Dr. J. M. H. Munro, D.Sc., F.I.C., during the past two years into the radioactivity of the waters and gases of the hot springs, which are embodied in a report to be published shortly. The waters have also been examined chemically and bacteriologically by Messrs. Cook and Barke, public Analysts of the Western Counties Laboratory, who report that "the water comes up quite sterile, and that none of the waters show any evidence of contamination with surface water." This confirmation of the absence of bacterial organisms is of conrse very satisfactory, but it would naturally be expected in a water of this special character and high temperature, especially by those familiar with the modern scientific view as to the origin of such waters, *viz.*, the combination of gases in the heated depths of the earth producing water which emerges, as at Bath, as what is knowu as a "juvenile" water, i.e., a newly formed water which has not previously been in the general circulation of water on the earth's surface.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

19,879.—Draux, G. E. J.—Machine for chemical engraving. July 9th.

20,065.—Bataafsche Petroleum Maatschappij. — Absorbing ethylene, etc., by means of sulphuric acid. July 9th.

20,067.—Goldschmidt Akt.-Ges., T.—Production of alkylene oxides from alkylene chlorhydrins. July 10th.

20,347.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of yellow ferric hydroxide. July 12th.

Specifications Published.

293,495.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of alkali nitrates.

293,504.—Merck & Co.—Colloidal iodine and the process of making the same.

293,514.—Thaysen, Dr. A. C., Galloway, L. D., and Bakes, W. E.—Production of alcohol and acetone from vegetable matter.

293,592.—Aurig, M., and Brucklmayr, G. Treatment of gases for removal of hydric sulphide and carbonic acid.

Abstract Published.

291,249.—Chromic acid.—Schuster, R., 94, Paulsbornerstrasse, H a l e n s e e , Berlin.

A solid form of chromic acid soluble in water is obtained by evaporating a mixture of chromic anhydride or sodium or potassium chromate or bichromate, sulphuric acid, sodium or potassium silicate or a mixture thereof, and water until the gelatinous mass first obtained becomes crystalline. Preferably the chromic anhydride &c., and a solution of waterglass are added to the sulphuric acid mixed with water, suitable proportions to be used being indicated in the Specification. The mixture may be evaporated under reduced pressure at about 125° C., and is allowed to fall to 120° C.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His *Majesty's Stationery Office.*

NEMURAL.

492,299.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. July 18th.

HOMOZONE.

490,863.—A chemical preparation, in class 1, for producing oxygen gas by the addition of water. — Kenneth Samuel Culloch Bone, " Rosslyn," 17, Long Lane, Garston, Liverpool. July 18th.

LYTOPHAN.

486,956.—Chemical substances prepared for use in medicine and pharmacy.—Schering-Kahlbaum Aktiengesellschaft, 170 - 171, Mullerstrasse, Berlin, N.39, Germany. July 18th.

HAVEG.

489,866.—Chemical substances in class 1 which includes acids, potash, salts and other chemical substances used in manufactures. — Säureschutz-Gesellschaft mit Beschränkter Haftung, 49 - 50, Rudowerstrasse, Berlin-Altglienicke, Germany. July 18th.

JUST PUBLISHED.

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TENDERS.

The Commissioners of His Majesty's Works, etc., are prepared to receive Tenders before 11 a.m., on TUESDAY, 14TH AUGUST, 1928, for the supply of

SODA ACID EXTINCTEURS AND CHARGES.

Forms of Tender, etc., may be obtained on application to the Controller of Supplies, H.M. Office of Works, etc., King Charles Street, Westminster, London, S.W.1.

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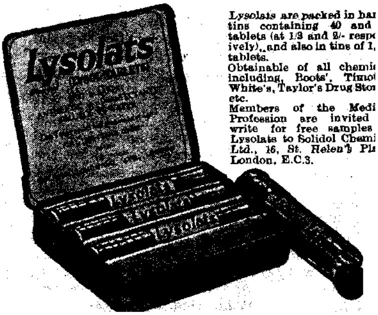

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Members of the Medi Profession are invited write for free samples Lysolats to Solidol Chemi Ltd., 16, St. Helen's Pl London, E.C.3.

ford, by the way, who discovered that the negative hydrogen atom holds up two electrons.) If we suppose that each proton he dislodged was a damaged planet then it is easy to see that with the " ammunition " he used the damaged planet may well appear as a proton instead of an L X-ray. For in such a bombardment he uses swift Alpha rays from Radium C and as these are double-positives the coronal electrons may well have been attracted away after them instead of following their own nucleus in its flight. It is not as if only one Alpha ray were used. The coronal electrons do not have much chance of behaving normally when they are bombarded with Alpha rays. It is far more probable, too, that the atom yielded up a damaged planet in the bombardment shock than that Sir Ernest Rutherford knocked a proton out of the nucleus for he, himself, has shown us what intense repulsion the two nuclei have for each other, in other words there is no chance of a collision between the two double-positives, their mutual repulsion is too great. But an already-weakened planet may well be able to wrench itself free in the shock given to the atomic sun by this invasion.

We have reason, then, for believing that the damaged planet, that would have departed as an L X-ray, can be made, by an Alpha ray bombardment, to leave the atom as a proton, its three electrons having been attracted away from it. But surely, it will be objected, if the L X-ray is a hydrogen atom, it shows itself as such after it has passed out of the excitement of being ejected from its little world and regains its weight of 3. This objection can be met since H_3 is apparent after a cathode ray bombardment. The cathode rays, as negatives, may be trused not to lure away the coronal electrons in flight after their nucleus. Sir Joseph Thomson writes (" Rays of Positive Electricity," p. 196):— " When salts and minerals are bombarded we find when we analyse by the positive rays the gases given off, a line corresponding to a substance with atomic weight 3 as well as the helium line. In fact the ' 3 ' line occurs even more frequently in such cases than the helium line, for it is rare to find it absent after any solid has been bombarded by cathode rays, and it not infrequently occurs when no trace of the helium line can be detected."

After fully considering the matter Sir Joseph Thomson comes to the conclusion that this " 3 " gas is probably hydrogen, triatomic hydrogen, for, of course, as he does not approach the atom from our point

From KOH Sir Joseph Thomson finds that this gas is freely given off. Potassium is an element of uneven atomic weight. We should therefore expect H_3 to be in evidence. Helium also since the departure of the potassium planet leaves only the sun-atom of that system. This helium atom may succeed in spite of the bombardment in hanging on to the new system (sodinm-chlorine) and so make it appear as argon, or it may be shot away. In this case there would be no argon but an atom of chlorine and an atom of helium in addition to the H_3.

Thus hydrogen like helium, appears to be the product of decay. The atom in breaking down will yield up planets that turn to hydrogen and sun-atoms that turn to helium. The few twin-planets, such as uranium, thorium, radium, cadmium, tin, etc., will also yield up helium wheu disintegrating.

If, then, our hydrogen atoms have come from L X-rays, we can but suppose that the hydrogen atoms that yield the red light and have but one far distant electron are those atoms that have come from the lightest atoms, snch as lithium, beryllium and boron, and so have had their three electrons at such a distance (low frequency) that they have been able to lose two of them almost at once and reduce their weight to 1. When we come to the hydrogen atoms that yield a green light, we shall look upon them as having come from heavier elements and so having the electrons of a higher frequency. They therefore have to keep two electrons, have to be negatives instead of positives and have the atomic weight of 2. When we come to the hydrogen atoms that yield the blue light we can but surmise that they are atoms that have the three electrons enfolding them, the outermost of which reflects violet light while the inner two with their nucleus still continue to reflect green. They will have the atomic weight of 3. When we come to the hydrogen atoms that yield violet light we shall have to picture the three electron orbits as being very much closer together. And so we pass into the ultra violet in which the orbits have become so small as to take the atoms out of the range of visible light. But we cannot end even here for since single elements as well as twin-elements are disintegrating in the radio-active series, yielding us Gamma rays as well as the helium of Alpha particles, we have to follw our hydrogen atom even into the Gamma ray—the shortest of all X-rays. " The Gamma rays," writes Dr. Andrade, " are electromagnetic waves of the same

trum of radium B and radium C has been investigated by Rutherford and Andrade, who made use both of the reflexion at a crystal face and the method of transmission through a crystal. The spectrum consists of a number of discrete lines, whose wave-lengths vary between .72 × 10^{-9} and 1.4 × 10^{-8} cm.; *it is not yet definitely established* if there is a continuous background to the spectrum. The softer rays coincide within the limit of experimental error with lines in the L series of the X-ray spectra of lead and bismuth; of the harder rays some, but not the most penetrating coincide with lines in the K series of the same elements." ("*Structure of the Atom*, p. 44.)

The M series of X-rays is not so important since it only concerns a few of the heaviest atoms. *It would appear to take its* rise from the growth of the atomic system. As the planets become more and more numerous it apparently becomes more and more difficult for any negative particle that has been attracted to the sun-atom to make its escape. It may, it would seem, be held up until some strongly-placed planet leaves the atom when it will depart with it and complicate its X-ray spectrum.

ROYAL INSTITUTION OF GREAT BRITAIN.

The following paper was read at the meeting held on Friday, June 8, 1928, Sir Robert Robertson, K.B.E., M.A., F.R.S., Hon Secretary and Vice-President, in the chair :—

The Waves of an Electron. By GEORGE P. THOMSON, M.A., Professor of Natural Philosophy, University of Aberdeen.

The history of the newer physics, as it may be called, is largely the history of the very successful attempts which have been made to explain the facts of the physical universe in terms of electricity. In particular, the natural units of electricity, the electron first isolated as the carrier of the negative charge in the cathode rays, and the more massive proton with its equal positive charge, have been the bricks out of which physicists have tried to build model atoms. But until recently the only properties which could be attributed with certainty to the electron were its mass, 9 × 10^{-28} gram., and its charge -4.77 × 10^{-10} electrostatic units. It is indeed possible to calculate a "size" on the assumption that it follows the same laws as a charged found, 3.7 × 10^{-13}, is neither confirmed nor contradicted by any experimental evidence.

To show, as I hope to do to-night, why we are now obliged to ascribe much more complicated properties to the electron, I must make a digression into optics, as it was from this direction that the theory comes which leads to the experiments I have to describe. It is well known that there are a number of phenomena which are instances of wave-motion in what used to be called the ether, though it seems now more fashionable to call it space. Such are wireless waves, light, ultra-violet radiation, X-rays. They differ only in wave-length, and it is convenient to refer to them all as light.

Now at the beginning of the century, the wave theory of light was one of the most firmly established parts of physics. It is true that for many purposes light was treated as consisting of rays, *i.e.*, effects travelling in a straight line, but this was merely an approximation used for convenience in calculation, and not regarded as of any great physical significance. The evidence for waves (interference and diffraction) was, and remains, overwhelming. Gradually, however, a series of experimental and theoretical results accumulated which showed that this was not the whole story, and in particular which only depended on the *kind* of light and not at all on the *intensity*. If light consists of continuous waves this seems almost impossible; but it is just what we should expect if, as Newton firmly held, light is due to a stream of corpuscles. In such a case if one o fthese hit an electron it would give to it an energy which would be quite independent of the number of other corpuscles present in the stream, *i.e.*, of the intensity of the light.

Prince Louis de Broglie has hit on a brilliant synthesis of the two views. Put very briefly it comes to saying that light is indeed corpuscular, but that the corpuscles are accompanied and guided by waves. Now the bearing of this on our subject is as follows: de Broglie's theory is quite a general one, and should apply to *any* sort of corpuscular motion, in particular electrons should be accompanied by waves which determine their motion. It would seem at first sight that this would involve a contradiction with what is already known about the motion of electrons. For example, waves spread after passing through a small aperture, while electrons can be concentrated into a fine beam by a tube or series of slits. But it is all a question of wave-length. Ordinary visible light only

because its wave-length is small compared with the size of ordinary objects. Wireless waves bend much because their wave-length is large.

There is in fact a relation pointed out more than a century ago by Hamilton between optics and dynamics. The laws of dynamics in their most general expression, the principle of action, are mathematically identical with Fermat's principle which is the most general statement of optics on the ray theory. Now in optics rays are an approximation to the wave theory, more and more nearly true the smaller the wave-length; perhaps the accepted mechanics of Newton and *Hamilton* is also only an approxixmation, true in practice because the wave-lengths concerned are very small? If so, we must develop a new mechanics to deal with cases when the wave-length is not of negligible size.

To-night I shall only speak of the mechanics of a free electron. Earlier in the year the Institution had the privilege of hearing from Professor Schrödinger an account of the rapid progress that has been made with the wave-mechanics of the electrons inside the atom, a progress mostly due to Professor Schrödinger himself.

De Broglie's results are as follows :—For any moving particle the wave-length $\lambda = h/(\text{momentum})$ where h is Planck's constant $= 6.58 \times 10^{-27}$. This in fact comes out negligibly small for any ordinary body. Even for an electron moving with the moderate energy of 150 colts it is 10^{-8} cm., or about that of a soft X-ray while for cathode rays of, say, 15,000 volts it is 10^{-9} cm.

Still, Sir W. Bragg and his son have shown us how to measure the wave lengths of X-rays, small though they are, and the electron waves may yield to a similar treatment.

We must first consider some general properties of these waves. According to de Broglie the speed of the waves, V, is c^2/v, where v is the speed of the particle, and c the velocity of light. They are thus faster than light. This result would be contrary to relativity if the waves carried energy, and so could transmit a signal, but as the energy is supposed associated only with the *particle* this objection does not come in; indeed, on the classical optical theory, cases are known of metals, such as sodium, having a refractive index less than unity, which implies a wave velocity greater than c. From the above two equations, taking account of the variation of mass with speed,

$$V^2 = c^2 + \frac{m_0{}^2\lambda^2}{h^2c^4},$$

and so depends on λ. Thus there is *dispersion*, in the optical sense, for these electron waves even in free space.

The late Lord Rayleigh showed that in such a case, besides the velocity of the independent waves, there is what he called a *group velocity*, wihch is the speed with which the pattern formed by the superposition of several waves of slightly different wave-length moves along. Now an application of his formula shows that in this case the group velocity is precisely v, the speed of the electron, so that the electron carries its *group* with it (or the group carries the electron, if you prefer it), though the individual waves composing the group are perpetually shooting through from behind.

Again, since an electron is charged, its motion is affected by an electric or a magnetic field. On the older view of an electron this was simply a consequence of the laws of electricity. On the new view the electron goes where its wave takes it. Somehow the only possible paths are those along which the wave is propagated. On this view the change in motion of the electron is analogous to the change in direction of a ray of light when it enters a refracting medium. In fact, by choosing the field in an appropriate manner, we can imitate the effect on light of a corresponding piece of glass. For example, we can make a field equivalent to an ordinary convergent lens and bring electrons to a focus.

But, of course, this is only a *translation* between one view and the other. To test the new theory we must use something which has a regular structure comparable in size with the supposed wave-length. Here the wide experience obtained with X-rays comes to our aid, and the natural regularities of a crystal give what is needed. The regularly spaced atoms of a crystal each scatter the waves, since they scatter the electrons. Such a system of regularly arranged scattering points produces, as is well known, a peculiar effect on a simple wave, which is deflected into a few definite directions. It forms, in fact, the three dimensional analogue of the ordinary optical ruled diffraction grating. The effect can be illustrated in its simplest form with waves on a liquid.

The idea of using a crystal in this way has been carried out by Davisson and Germer in America, and by Reid and myself in this country. As my time is limited, you will,

perhaps ,pardon me if I limit my description to our work, especially as Davisson's and Germer's experiments lead to the same general conclusions. As the atoms of a crystal are arranged in three dimensions, the result is somewhat more complicated than in the experiment you have just seen. If a beam of X-rays is passed through a single crystal and allowed to fall on a photographic plate, the developed picture is a series of spots whose position depends on the structure of the crystal. If it passes through a powder formed of a large number of very small crystals arranged at random the spots due to each tiny crystal join together to form a series of concentric rings, whose relative sizes depend on the crystal structure, the absolute size of the whole pattern being proportional to the wavelength of the X rays. Both these methods, or their equivalent, have of course been extensively used in the investigation of crystal structure by X-rays, nowhere more successfully than in this Institution.

The apparatus we have used is a direct application of this method to the study of electrons.

It is necessary to use very thin films because electrons have vastly less penetrating power than X-rays, and they must not only penetrate the film, but be so little affected by it that the scattering is what is technically called single." In practice this means that only a small minority should be appreciably scattered at all. The films we used were only a few millionths of a cm. thick, in fact it is no use trying a metal film unless it is thin enough to be transparent. Some of the metals show uniform rings, others spots arranged round rings. Both can be paralleled in the analogous results with X-rays.

In comparing theory with experiments we have three separate checks. First, the relative sizes of the rings must conform to the known crystal structure. For the metals I used these go as the square roots of certain integers. In fact, the first few rings should be in the ratio $\sqrt{3} : \sqrt{4} : \sqrt{8} : \sqrt{11} : \sqrt{12} : \sqrt{16} : \sqrt{16} : \sqrt{19} : \sqrt{20}$. The following table shows the extxent of the agreement.

RELATIVE DIAMETER OF RINGS.

Metal	$\sqrt{3}$	$\sqrt{4}$	$\sqrt{8}$	$\sqrt{11}$ / $\sqrt{12}$	$\sqrt{16}$	$\sqrt{19}$ / $\sqrt{20}$	$\sqrt{24}$	$\sqrt{27}$	$\sqrt{35}$ / $\sqrt{36}$
Gold	$\sqrt{2.98}$	$\sqrt{4.02}$	8.00	$\sqrt{11.2}$		$\sqrt{19.8}$			
	$\sqrt{3.05}$	$\sqrt{4.05}$	8.00	$\sqrt{11.4}$		$\sqrt{19.1}$			
	$\sqrt{2.96}$	$\sqrt{4.08}$	8.00	$\sqrt{11.2}$		$\sqrt{19.5}$	$\sqrt{22.7}$	$\sqrt{26.6}$	$\sqrt{35.4}$
Aluminium		$\sqrt{4.00}$	8.00	$\sqrt{10.9}$	$\sqrt{16.5}$	$\sqrt{20.4}$		$\sqrt{27.0}$	
		$\sqrt{3.98}$	8.00	$\sqrt{11.0}$	$\sqrt{15.7}$	$\sqrt{21.2}$		$\sqrt{27.8}$	
		$\sqrt{4.02}$	8.00	$\sqrt{10.9}$	$\sqrt{15.9}$	$\sqrt{19.4}$		$\sqrt{26.8}$	$\sqrt{35.0}$
Platinum	$\sqrt{3.00}$	$\sqrt{4.00}$	8.00	$\sqrt{10.9}$	$\sqrt{15.8}$	$\sqrt{18.4}$	$\sqrt{24.0}$	$\sqrt{26.5}$	
	$\sqrt{3.07}$	$\sqrt{4.01}$	8.00	$\sqrt{11.8}$					
	$\sqrt{3.04}$	$\sqrt{4.08}$	8.00	$\sqrt{11.2}$	$\sqrt{16.4}$	$\sqrt{19.0}$	$\sqrt{23.4}$	$\sqrt{27.1}$	$\sqrt{35.0}$

Secondly, if de Broglie's Theory is true the wave-length is inversely as the momentum, *i.e.*, apart from a small relativity correction the product of the diameter of any one ring into the square root of the measured energy of the rays should be constant.

Aluminium			Gold			Platinum	
Voltage	$D\sqrt{P}$		Voltage	$D\sqrt{P}$		Voltage	$D\sqrt{P}$
21.800 ...	(359)	...	21,000 ...	(344)	...	18,200 ...	(378)
34.500 ...	385	...	33,700 ...	377	...	25,500 ...	395
45,000 ...	385	...	44,000 ...	377	...	34,500 ...	420
57,600 ...	395	...	55,000 ...	379	...	40,000 ...	401
64,000 ...	385	...	58,000 ...	376	...	45,000 ...	413
Means	387			377			407

Celluloid.

Voltage	D√P	Voltage	D√P
9,800	185	23,200	193
11,500	175	30,500	186
16,100	189	36,000	193
16,800	191	42,500	189
21,000	190	50,000	195

Thirdly, the actual size of the rings is calculable from the assumed wave-length, and the known spacing of atoms in the crystal. The best ways of showing the agreement is to work back, calculating the crystal spacing from the experiments and theory, and comparing with that found by X-rays.

Size of Crystal Unit.

	Aluminium	Gold	Platinum
X-ray measurements	4.046×10^{-8}	4.06×10^{-8}	3.91×10^{-8}
Cathode ray measurements	4.06×10^{-8}	4.18×10^{-8}	3.88×10^{-8}
	4.00×10^{-8}		3.89×10^{-8}

Finally, in a few cases the individual spots can be used. This is when the small area struck by the rays happens to consist wholly or mainly of a single crystal. In such a case we can find the orientation of the crystal from some of the spots and see if the others check.

I think that this agreement may be regarded as establishing the essential truth of the theory.

But there remain great difficulties of interpretation. What are these waves? Are they another name for the electron itself? How many waves in series does an electron have? What is the relation between the electron waves and those of light and X-rays? Some of these questions I should like very briefly to discuss, but I must warn you that we now leave the sure foothold of experiment for the dangerous but fascinating paths traced by the mathematicians among the quicksands of metaphysics. First as to the length of the train of waves. Here we have a little direct evidence. The sharpness of the rings depends, among other things, on this length. A short train of waves results in blurred rings. If we suppose the whole width of the rings due to dows. They undoubtedly saved a great deal this, I calculate from the fact that it is just possible to separate the √11 and √12 rings that there must be at least 48 ordered waves in the series. Probably there are many more, as several other causes tend to widen the rings. But this may only apply to my particular experimental arrangement. Theoretically it seems probable than an exact knowledge of the speed of an electron implies that it has an infinite wave-train associated with it, just as ideally monochromatic light implies an infinite train of light waves. Since there cannot actually be an infinite wave-train this means that an electron's speed can never be exactly known, which in one sense is not surprising, for all measurement is approximate, and it can be shown that the conditions under which the velocity of an electron could be found with great accuracy are precisely those in which a long train of waves could accompany it. But suppose we have a short train of waves. The velocity is uncertain. Is this because there are really many electrons concerned and they have different velocities? In most of the experiments one could devise there would be, but I don't think this covers all cases.

Imagine a small speck of radio-active material which emits electrons as fast β rays. If you make it small enough the particles may follow each other at intervals of minutes, or days, or years, if you like. It seems impossible to suppose that these electrons have any connection with each other. They come from different atoms at widely different times. One is forced to the conclusion that each must have its own separate wave system. But this wave train must be finite, probably in fact it is rather short, and one reaches the surprising conclusion that the electron *has* no definite velocity, even though it may be moving in force-free space. This raises obvious difficulties about energy which I do not pretend to be able to solve, but the work of Ellis and Worster on Ra.E. seems to show that there is an uncertainty of this kind, which is in fact of about the right amount.

As regards the relation between electron waves and light waves: they are certainly not the same, even when their wave-length are equal. They go at different speeds: one is refracted by electric and magnetic fields, while the other is not, their penetrating powers in ordinary matter are widely different. If they are the actual motion of an " ether " it must differ in some way in the two cases.

My father, Sir J. J. Thomson, has shown that the relation between wave-length and velocity of the electron waves is precisely that which holds for light waves in a medium containing free electric charges. The properties of such a medium have recently become of great importance, for the possibility of long distance wireless has been shown to be due to the existence of a region with these properties in the upper atmosphere. It it tempting to regard this agreement as something more than a mere coincidence, and to consider the waves of the electron as waves in an ether modified by the presence of the tubes of force, which since the days of Faraday many physicists have regarded as having a real existence round an electric charge. Thus the electron would provide, not indeed its own ether, but the necessary modification of that ether.

But I should like also to suggest another possibility, though you may perhaps think it rather a cowardly way out of the difficulty.

Personally I see no necessity for there to be any vibration of a material or quasi-material object. The essence of a wave is the transference of a *state* according to certain laws, for example, a " heat wave " crossing the Atlantic. The state may, or may not, be one of motion. On this view, the function of the waves is to produce conditions at the electron which oblige the latter to move along the instantaneous position of the wave-normal (in the absence of a magnetic field), and along another, but determinate, direction in a magnetic field. But though it seems possible to regard the motion of the electron as determined by the wave in its immediate neighbourhood, it must never be forgotten that the direction of each part of a wave-front depends on the history of the whole wave-front. Any circumstances that influences one part of a wave influences the whole, and this is of the essence of wave motion. The electron is influenced by conditions at a distance, but indirectly through its waves. Thus in our experiments the electron is influenced not merely by the nearest atoms of the crystal, but by the whole of the crystal which is exposed to the beam. The *width* of the wave-front must be taken as the cross-section of the tube through which the electrons pass.

But although the whole wave-front, in theory, affects the electron, all parts do not affect it equally. Thus, suppose the width of the beam were diminished by gradually reducing the size of the tube, apart from the obvious diminution in intensity, the only effect would be a diminution in resolving power due to the reduction in the number of grating elements. When the resolving power is large a considerable change, such as is produced by halving the number of atoms affected, produced comparatively little change in the pattern of the diffracted rays, *i.e.*, the distribution of scattered electrons.

The main features of the pattern are determined by the first few elements, just as, on the older view, the direction of the scattered electrons would be mostly determined by the forces exerted on it by the atoms near which it goes and comparatively little by the more distant ones.

The easiest way of looking at the whole thing seems to be to regard the waves as an expression of the laws of motion. The uniform motion of Newton's first law is replaced by a simple plane wave, and so on. On this view, the electron remains the reality, and this seems right, for after all it is the electron as a particle which is actually detected in any conceivable experiment, and the waves come to bear the same sort of relation to it that Newton's or Einstein's law of gravitation bears to the planets which obey it.

It is remarkable how near this view comes to that proposed by Newton in the case of Light, which as we have seen is analogous, and I can hardly give a better statement of the position, allowing for slight changes in terminology, than by quoting what he says :—

" Those that are averse from assenting to any new discoveries but such as they can explain by hypothesis, may for the present suppose, that as stones by falling upon water put the water into an undulatory motion, and all bodies by percussion excite vibrations in the Air; so the Rays of Light, excite vibrations in the refracting Medium or Substance . . . that the vibrations thus excited are propagated in the refracting or reflecting Medium or Substance, much after the manner that vibrations are propagated in the Air for causing Sound, and move faster than the rays so as to overtake them . . . and that every Ray is successively disposed to be easily reflected or easily transmitted, by every vibration which overtakes it. But whether this Hypothesis be true or false I do not here consider."

In what follows he contents himself by describing the experimental facts. But his hypothesis, the guess of genius, after a century of discredit, is reasserting its superiority over the more logical, but less inspired ideas of the early nineteen century.

THE ASSOCIATION OF BRITISH *CHEMICAL MANUFACTURERS.*

The Twelfth Annual General Meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1., on Thursday, 12 July, 1928.

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Sir Max Muspratt, in seconding the adoption of the Report, said that he would like to make one or two remarks with regard to Exhibitions. Exhibitions have for many years past been the curse of industry, at any rate of the heavy industries, and those industries not coming direct contact with the consumer. But two great exceptions had to be made: one was Wembley and the other the British Industries Fair. There was no doubt that they had played a part in bringing before people from every part of the world what British Industry was doing and what it could do, and he thought that the A.B.C.M. could feel very proud that they set to work when most people were hesitating. The success of that magnificent Chemical Section at the Wembley Exhibition was due to the fact that they started by backing the British Industries Fair, and he hoped that for many long years they should continue to do so.

With reference to the Monograph on Chemical Industry, he thought that last year it had an extraordinary effect in Geneva, particularly in pulling together all the English-speaking races on lines of thought that helped so much on the general resolutions they were then carrying out at the Economic Conference. The Germans very cleverly got in with a very good Monograph upon the Chemical Industry which, not directly but by inference, implied that Germany was the only centre of the Chemical Industry and no other country in the world mattered. This shook the United States very badly, but they were not in a position, or at any rate were not quick enough, to get in first, and that original Monograph, prepared in a very few days, was probably one of the greatest triumphs the A.B.C.M. has ever achieved; in fact, it was an achievement that there would probably be no opportunity of repeating. It was desirable, when the follow-up Commissions were being held upon these important subjects, that the Monograph should be brought up to date, and it was very efficiently and ably brought up to date. He referred to the Chairman's remark that if the Economic Conference did nothing else, it did prevent the rise in tariffs. Undoubtedly, the psychology and mentality of the world was altered to the great advantage of a comparatively free trade country such as ours. With regard to Safeguarding and Dyestuffs, they must remember that it was a double-edged sword. Personally, he felt he could justify the action taken before any public tribunal of the world, under existing conditions, but it was a matter in which they must look upon both sides. If they wanted the tariffs of the world reduced they must not be too exigent as to the terms they asked for safeguarding their own industries and the retention of the Dyestuffs Act. Returning to the Monograph, he pointed out that it enabled us to show to critics who said that Great Britain was no longer the great free trade country she had been and therefore had no right to claim that tariffs should be reduced all round, and that our Chemical Industry was so enormous that the comparatively small sections in which they did require breating space did not upset the great argument that, broadly speaking, as compared with the rest of the world, we were a free trade nation, and that if we had to make exceptions, it was because they were forced upon us.

The Relief of Rates is a subject which he ventured to say nobody at the moment understood, but it is a great new orientation, and an industry such as the Chemical Industry, which has taken such a large part in forwarding every progressive movement should wish to give the very fullest support it possibly can to the whole of this new policy which is based upon the fundamental idea ,forgotten by so many people, that, after all, production lies at the basis of the whole prosperity of this country. Without production it is impossible to have payment for services of every kind, and without production and export it is impossible, indefinitely, to maintain the standard of living which it is desired to maintain in this country. So whatever the A.B.C.M. does in criticising this detail or the other, he was sure that the Council would be imbued with the spirit that this is a great new orientation of the whole system of taxation for dealing with unemployment and with Poor Law relief, and that it requires its most wholehearted support, however strong it may have to make representations in detail. At the same time he felt it ought to be put on record that this is a great movement for the improvement of the industries of the whole country, a great movement for the readjusting of burdens amongst the various portions of the community, and he was sure it deserved the most cordial support of the Coun-

cil in every way. He asked members to remember also that in their districts, when questions came up in which they were faced with what seemed a ridiculous point of detail, they should keep in mind the big thing first and give the best answer they could to the particular question of difficulty that has cropped up; that question of difficulty should be sent on to the Council of the A.B.C.M., and, either directly or through the F.B.I., it should be dealt with in as fair and equitable a manner as was possible in an extraordinarily complicated situation and with an extraordinarily complicated problem.

After the Honorary Treasurer (Dr. E. F. Armstrong) had made a statement regarding the accounts, a general discussion followed.

(To be continued.)

THE WIDER ASPECTS OF COSMOGONY.

By J. H. JEANS, M.A., D.Sc., LL.D., F.R.S., Secretary of the Royal Society.

(Before the Royal Society of Arts, Trueman Wood Lecture, 7 March, 1928, Sir Frank Watson Dyson, K.B.E., LL.D., D.Sc., F.R.S., Astronomer Royal, in the Chair.)

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The standard sizes of stars predicted by this theory depend on the atomic weights of the atoms of which the star is composed. Thus the observed sizes of the stars disclose the atomic weights of the stellar atoms; they indicate that the stellar atoms are probably rather heavier than the heaviest atom, uranium, known on earth. The atoms which reveal their presence in stellar spectra are, of course, atoms of the ordinary terrestrial elements — hydrogen, iron, calcium, and the like. These, being the lightest atoms in the star, must naturally float up to its surface, and as the earth was originally formed out of the surface of the sun, the earth is necessarily composed of them. But it now appears likely that down in the depths of the stars are other unknown and heavier atoms. We may almost say that it must be so, for no terrestrial atoms, not even radium or uranium, can produce anything like the amount of energy which these stellar atoms are observed to produce.

The immensity of space is paralleled by that of time. We can estimate the ages of the stars from the impression that time has made upon them, just as we estimate the age of a tree from the number of subdivisions of its stem, or of rings in its cross section. There are three principal methods of doing this. The orbits of binary stars, which are circularat birth, are gradually knocked out of shape by the forces from passing stars. As we can calculate the rate at which this process occurs, the shape of stars' orbits can be made to reveal their ages. The moving clusters provide a second method. Groups of bright stars such as the Great Bear, the Pleiades, Orion's belt are often found to consist of exceptionally massive stars which move in regular orderly formation through a jumble of slighter stars, like a flight of swans through a confused crowd of rooks and starlings. Swans, however, are conscious beings, and continually adjust their flight so as to preserve their formation. The swan-like stars cannot do this, so that their orderly formation must in time be broken by the gravitational pull of other stars. When this happens the lighter stars are naturally knocked out of formation first, while the most massive stars retain their formation longest.

It is gratifying and significant that all three lines of investigation lead to the same result : the stars are found to be some millions of millions of years old, perhaps from 5 to 10 millions of millions. We cannot state their age with much precision, but it is the general order of magnitude, not the exact figure, that is important.

Year after year, century after century, for millions of millions of years the sun radiates enough energy from each square inch of its surface to keep a 50 h.p. engine continually in action; still hotter stars may radiate as much as 30,000 h.p. per square inch. If this energy were produced by the combustion of coal, the stars would all be completely burnt out in a few hundreds or thousands of years. Where, then, shall we find a source of energy to last millions of millions of years?

Over twenty years ago I drew attention to the enormous store of energy made available by the annihilation of matter, by positive and negative electrons falling into and annihilating one another, thus setting free the whole of their intrinsic energy as radiation. On this scheme neither energy nor matter had a permanent existence, but only a sort of sum of the two; each was, theoretically at least, convertible into the other. Whether energy is ever transformed into matter we do not know; probably not. But the falling together of electrons and protons forms the obvious mechanism for the transformation of matter into energy, and it now seems practically certain that this is the

actual source of the radiation of the stars. Each square inch of the sun's surface is in effect a searchlight discharging radiation into space at the rate of 50 horse-power, and so is discharging mass at the rate of a gramme and a quarter a century, and the sun's surface is so large that the sun as a whole is discharging mass into space at the rate of 250 million tons a minute. Now the sun has no source of replenishment. It must have weighed 360,000 million tons more yesterday than to-day, and by to-morrow will weigh 360,000 millions tons less. These are not mere speculative statements; they rest on observation, and on generally accepted principles which are directly confirmed by observation.

Allowing for the fact that a more massive star emits more radiation than a less massive one, we can calculate that five or ten million million years ago the sun must have been several times as massive as it is to-day, so that it has already lost most of the mass it had at birth. Of each ton it had at birth only a few hundredweights at most remain to-day. The loss of mass which accompanies radiation is, then, no mere academic hair-splitting :. It is a real astronomical phenomenon, and young stars must be many young stars must be many times as massive as old stars.

Five million million years ago the sun had stored up within it the energy which was destined to provide its light and heat until to-day, and the mass of this energy was many times the present mass of the sun. No means is known by which so much mass could be stored except in the form of electrons and protons. Thus we must suppose that the radiation of the sun through these millions of millions of years has been produced by the annihilation of electrons and protons which existed in it originally, but no longer exist now. These electrons and protons are pure bottled energy; the continuous breakage of these bottles in the sun sets free the radiation which warms and lights our earth, and enough unbroken bottles remain to provide light and heat for millions of millions of years to come.

The amount of energy made available in this way is amazing. The annihilation of a pound of coal a week would produce as much energy as the combustion of the five million tons a week which are mined in the British Isles, while a single drop of oil would take the Mauretania across the Atlantic. When we speak of the efficiency of a steam engine as 5 per cent. or so we regard complete use of the thermal energy of combustion as 100 per cent. efficiency. If we measure the work done against the total intrinsic energy of the fuel, as made available by its complete annihilation, the efficiency is more like 0.00000001 per cent. On this scale the efficiency of the sun and stars is exactly 100.00 per cent.

Modern physical theory shews that the annihilation of an electron must produce a single flash of radiation of wave-length far shorter than any we can produce on earth. As this radiation threads its way through a star, its wave-length is continually increased, or, to use the technical term, the radiation is continually softened. In time it becomes γ-radiation, then hard X-radiation then soft X-radiation, and finally it emerges from the surface of the star as ordinary light and heat. Consider, however, an electron which is annihilated not inside a star but outside in free space, or in one of the almost transparent nebulæ. The short wave-length radiation now undergoes no softening, but travels on until it meets something capable of checking it. Thus all astronomical bodies, including the surface of the earth, ought to be under continual bombardment by radiation of shorter wave-length, and consequently of greater penetrating powers, than any we can produce on earth.

The stars are almost certainly born in vast nebulæ. These nebulæ shew a great variety of shapes, but a single thread connects them all; they are the shapes of huge masses of gas endowed with different amounts of rotation. So definitely is this the case that when Hubble recently tried to classify the shapes of these nebulæ, deliberately and avowedly shutting his eyes to all theoretical considerations, he found that purely observational considerations compelled him to classify them in precisely the sequence I had predicted on theoretical grounds some ten years earlier.

A huge mass of gas which was entirely devoid of rotation would of course assume a strictly spherical shape; rotation would flatten this shape out, just as the earth is flattened by its rotation, until ultimately most of the matter was spread out in a thin disc. But mathematical theory shews that the thin disc-like structure could not remain a mere featureless mass of gas. Just as the cooling of a cloud of steam causes it to condense into drops of water, so the cooling of a cloud of gas causes it to condense into detached masses. We see the phenomenon in progress in nebular photographs; it is a necessary theoretical consequence of the

laws of gases and the law of gravitation. Now the same theory which predicts that the phenomenon must happen, predicts the scale on which it will happen. We can calculate how much matter will go to the formation of each "drop," and the calculated masses of the drops come out to be just about the same as the masses of the stars. And indeed these drops are stars, and the process just described is that of the birth of stars. Unmistakeable stars have been observed in the outer regions of many of the spiral nebulæ.

In these nebulæ, then, we are watching the birth of stars, the transformation of an inchoate mass of gas into an "island universe" of stars. Indeed Hubble found it necessary to end up his classification of nebulæ with clouds of stars. At one end of his continuous sequence is a nebula, shaped like a mass of rotating gas, in which not a single star is visible : at the other end a star-cloud in which nothing but stars are visible. Our galactic system of stars is probably the final product of just such a transformation, the milky way still recording the position of the equatorial plane of the original nebula.

Stars born in this way may meet with a variety of accidents and these result in different observed astronomical formations. A star may rotate too fast for safety, just as a flywheel may; when this happens it breaks into two and the two stars so formed revolve endlessly about one another as a binary system. Two stars may run into one another, although this is very rare. A more common occurrence is for two stars to escape running into one another by a narrow shave. When this happens huge tides are raised on the two stars involved, and these may take the form of long streamers of gas, which ultimately condense into "drops" just as did the gas in the outlying regions of the spiral nebulæ. It seems reasonably certain that the planets were formed in this way.

The birth of the solar system, then, resulted from the close approach of two stars, and if a second star had not happened to come close to our sun, there would have been no solar system. It may be thought that with a life of millions of millions of years behind it, one star or another would have been certain to come near enough at some time to tear planets out of the body of our sun. Calculation shews the reverse; even after their long lives of millions of years, only about one star in 100,000 can be surrounded by planets born in this way. A [illegible] is necessary to produce planets, and our sun with its family of attendant planets is rather of the nature of an astronomical freak.

In the thousand million stars surrounding our sun there are, at a moderate computation, not more than ten thousand planetary systems, because there has not been time for more than this number to be born. They are of course still coming into existence; calculation suggests a birth rate of about one per thousand million years. Thus we should have to visit thousands of millions of stars before finding a planetary system of as recent creation as our own, and we should have to visit millions of millions of stars before finding a planet on which civilisation, and interest in the outer universe, were as recent a growth as are our own. We are standing at the first flush of the dawn of civilisation, and are terribly inexperienced beings.

On any scheme of cosmogony, life must be limited to an exceedingly small corner of the universe. To our baby's wonderings whether other cradles and other babies exist, the answer appears to be that there can at best be very few cradles, and there is no conceivable means of knowing whether they are tenanted by babies or not. We look out and see a universe consisting primarily of matter which is transforming itself into radiation and producing so much heat, light and highly-penetrating radiation as to make life impossible. In rare instances, special accidents may produce bodies such as our earth, formed of a special cool ash which no longer produces radiation, and here life may be possible. But it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of bye-products; it seems to be the accident, and torrential deluges of life-destroying radiation the essential.

There is a temptation to base wide-reaching inferences on the fact that the universe as a whole is apparently antagonistic to life. Other quite different inferences might be based on the fact of our earth being singularly well-adapted to life. We shall, I think, do well to avoid both. Each oak in a forest produces many thousands of acorns, of which only one succeeds in germinating and becoming an oak. The successful acorn, contemplating myriads of acorns lying crushed, rotten or dead on the ground, might argue that the forest must be inimical to the growth of oaks, or might reason that nothing but the intervention of a

Abstract Published.

291,433.—Aliphatic acids. — Holzver-Holungs-Industrie Akt.-Ges., Konstanz, Baden, Germany.

Acetic and other aliphatic acids. — Aqueous, acetic acid or other volatile aliphatic acid is vaporised and treated with a salt capable of combining with the acid to form an acid salt, such as potassium or sodium acetate, or alkali or alkaline earth salts or mixtures of them, the acid salt formed being then treated to recover or utilize the acid. When pyroligneous acid is used it may receive a preliminary treatment to remove tar. The vapour of the aqueous acid is passed up a column into which concentrated potassium acetate solution is sprayed in counter-current. The liquor collected at the bottom is cooled, for instance in strongly-cooled jigging-troughs, and the separated salt, if desired after drying, is decomposed by hot air or in vacuo for instance at about 200° C. or may be utilised direct, for instance for the production of esters. The neutral acetate and the mother liquor may be used again. Alternatively, especially when sodium salts are present, the solution or solution mixture resulting from the absorption of the acid may be heated to distil off the acid without first isolating the acid salt.

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MANIFESTATION OF COMBUSTION EFFICIENCY.

By Robert Saxon, B.Sc., F.C.S. (London) Mem.Amer.Chem.Society.

In the internal combustion motor there should be no chemical reaction going on outside the cylinder. Oxidation of the carbon and hydrogen should be complete to carbon dioxide and water gaseous. It should not stop with the production of the monoxixde, should not by passing the dioxide over red-hot carbon deposit produce the monoxide nor should oxidation be going on at the end of the stroke. The engine diagram to a steam engine fitted with Corless valves gives a curve almost rectangular on the inlet, full pressure, and exhaust sides, and the curve of expansion is almost the theoretical hyperbola. There is in a modern steam-engine diagram little wiredrawing of the corners. Comparing this with that of a petrol engine we are impressed by the waste of fuel in the latter. For the same caloric value the area of the diagram is less than half that of the steam engine. Being single acting pistons, having to arrange for compression, delivering the exhaust at a temperature considerably above that of inlet, the cylinder heat pushing back part of the potential energy in the incoming petrol, and not having the immense advantage of condensation, it cannot be expected that the explosive type of engine can ever compete favourably from a point of view of thermo-dynamic economy with the steam engine. It is, however, silly to imagine that potential heat and kinetic energy should be poured out to be smothered in the exhaust pipe of a petrol engine. There is the caloric energy which ought to have expended itself in expansion in the cylinder. There are unburnt hydrocarbons owing to the rapidity of ignition and exhaust. The outrushing gases have kinetic energy which merely serves to make the motor emulate the machine gun, and scatter unburnt flakes of savoury fat upon the man behind. Neither carbon dioxide nor steam have any smell at all. Yet the products of combustion from many motors seem to have passed through the laboratories of old man Pluto, their perfume rare being like nothing else on earth. This foul belching vomit from the bowels of red-hot engines driving 'buses hour after hour without a chance to cool is infernal waste, and like all evil-smelling offal could be a source of power.

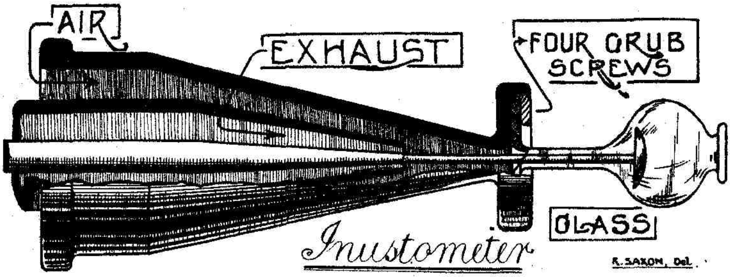
In an internal combustion engine there should be less possibility of loss of

the caloric wealth of the coal has to be tr ferred to the steam, this to be carried pipes to a valve chamber, then to a cylinc losing heat all the time. Yet the efficie of a modern quickly opening and cutting valve engine is as high as 80 per cent., wl the most efficient petrol motor cannot yi more than 60. This should not be so many cannot be expected to give out m than half of this. We should theref study the combustion going on in an eng of this description, and find a means ascertaining whether or not this combust is complete when the exhaust is delive The following heats of combustion instructive.

Carbon to CO	29,000 cal
Carbon to CO_2	97,000 ,,
Hydrogen	58,000 ,,
Methane	212,000 ,,
Ethane	370,400 ,,
Propane	529,200 ,,
Butane	687,200 ,,
Pentane	847,100 ,,
Hexane	1,000,000 ,,
Heptane	1,160,000 ,,

We see that carbon when properly bu is a richer source of energy than hydrog Burnt to the monoxide it does not yield c third that of dioxide. The difference l tween succeeding members of the metha series is about 159,000 cals. for the radi CH_2 and the heat of combustion for tl should be 97,000 + 58,000 = 155,000 ca The approximation of these two leaves or 4,000 cals to the breaking up of the carb molecule. Though heptane seems to gi up a great amount of heat in burning must be remembered that its molecule C_7H_{16} whereas methane is only CI Butane boils at 0.6 deg. C. and pentane 36.1. This latter can be manufactured a high state of purity, and calorific expe ments with this might profitably be co ducted to test the efficiency of a motor, l collecting the exhaust gases and passi them through hydrocarbons which abso unburnt gas but not the products of co bustion.

The sketch is a part section of a devi for revealing the presence of unburnt gase This is placed near the outlet valve so th some of the exhaust passes up the centr tube. In so doing it becomes throttled the neck, and by virtue of its kinetic energ its velocity becomes accelerated, and draws in air as shown. This mixture of g and air strikes the rod which is coated wi an occlusion agent as platinum black. Th



air. In the cup at the end is placed a paste containing a salt rich in oxygen. This will glow in the presence of soot as well as unburnt gas. It will be seen that this salt paste will last indefinitely if combustion is as it should be, and where it is kept glowing will last two or three hours, when it must be replaced. The bulb is of rich silica glass. Its shape tends to make the gases mix well before they meet in convection on the paste.

There has been tried a device to assist exhaustion, and thereby add to the efficiency of the motor. This works on the turbine principle whereby the exhaust gases impinge on the oblique pallets of a turbine, which is driven independently to run at a speed faster than is necessary to take the exhaust away. By so doing the sound is broken in such a way that a silencer is not needed, at least nothing like that used with the ordinary motor. The defect of this arrangement when tried years ago was that the turbine blades burnt away, but in these days of silicon, tungsten, and chrome steels it should be possible to overcome that difficulty. It was a fact that before the blades gave out the efficiency of the engine rose in one case 27 per cent. The power required to drive the turbine comes partly from the exhaust itself, and owing to the fact that exhaust becomes quicker the engine begins to run faster as the action proceeds. In the modern motor the exhaust lags about in the same pipe as the income mixture uses, and fouls the charge somewhat. If the exhaust were assisted there would be undoubtedly very little soot, and soot becoming red hot means carbon monoxide, deadly poisonous, and as it has no smell is often allowed to do its fell work without any knowledge on the part of its victims that anything is amiss.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

The Twelfth Annual General Meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1., on Thursday, 12 July, 1928.

(*Continued from Page* 91.)

The Rt. Hon. J. W. Wilson referred to the work done by the various Group Committees, and especially their chairman, whose valuable presence on the Council they all appreciated. He said that of necessity those Groups must be the feelers of the Association for initiating new subjects, and for watching the interests of the Chemical trade as a whole. Although the present commercial position of the world, and particularly of this country, had suddenly awakened to " big businesses " following perhaps the example set by Germany and other countries, yet they must all remember that while big businesses are wonderful, they are only made in many instances, by the building up of small businesses in the first case, and that whilst they welcomed a strong and leading company in any section of business and a massing of interests, yet he thought they all agreed that a great deal depended upon the management of that company and the attitude adopted by it to the smaller businesses. Sometimes he still had a sort of individualist, by no means Communist or Collectivist, feeling in his mind, and he hoped that everything would be done to cultivate and encourage not only relations with, but the activity of, the smaller businesses in the Chemical Trade throughout the country by their big brothers. So far, they had nothing whatever to complain of in that connection.

The Hon. Treasurer (Dr. E. F. Armstrong) said that statistics were an extraordinarily mixed question. On the one hand, they certainly wanted, *vis à vis* the Government, accurate statistics and information. On the other hand, it was difficult, and often disadvantageous, to give statistics, and the problem for the Association was to try and get a happy mean between those two aspects of the case. There were many difficulties which he cited, so that they were placed in this invidious position: that the fuller the statistics, the more accurate they tended to become.

In regard to patents, he said that they all knew the extraordinary number of foreign patents taken out in this country during the last year and many of them were alarmed at those patents. The patents, for the most part, were not genuine inventions. They were taken out with the object of preventing British manufacturers making or using substances, often well known. The day was not far distant when important and far-reaching action would have to be fought on this question of foreign patents. They had in the Association a very important and representative Patents Committee which had from time to time dealt with general questions. He was going to make the suggestion that the Patents Committee should rather broaden its sphere of action and endeavour to get into touch with individual members and obtain from them information on this particular point with the object of getting cases together and perhaps ultimately seeing whether cases could not be fought. This abuse of our Patent law could not continue very much longer if British industry was to go forward free and unfettered, as it has every right to. No blame attached to our Patent Office. They were definitely bound down according to regulaions and according to the legal interpretation of certain regulations. What they had to do was to get a precedent set up which would enable the Patent Office to alter its methods and ways. He was perfectly certain that the Patent Office would be most pleased to have a precedent which was more in favour of what was the intention in granting a monopoly under a Patent. He believed that was a field of work in which the Association could do much during the [illegible] year or two.

[illegible] he thought that those of them [illegible]ly, [illegible]ars to the ground could hear who had their e[illegible] the drums of the distant rumblings o[illegible] [illegible] that the next Chair-

days in connection with two measures wl affected many of them in the room. ' General Election might or might not, m a change of Government but, at any r it would mean a hesitation and an indecis in action towards certain problems, part larly those problems of Safeguarding renewal of the Dyestuffs Act. It was fortunate that problems of real national portance, which ought really to be the s ject of a referendum and impartial natic attention, should be the subject of pa politics. But that was our system, and had to make the best of it. But it was qu obvious that whatever this Association done in the past and however strong t were to-day, that strength was going to wanted to the very last ounce to fight very difficult battles in front of th because, however proud they were of tl achievements, they did know that t still required such assistance as those measures, either in their present or so modified form, could give them. He quite certain that the efforts of all meml of the Association and of the Council wc have to be very steadfastly and unite directed towards seeing that they at le got the minimum security in the fut Therefore, he felt, that if any justifica was required for the continuance of Association, they could say to-day n than ever that the Association was ne sary.

Mr. Dawson said that he wished to ac tuate and emphasise the speech made Dr. Armstrong and to appeal to Sir I Muspratt when he next went to Geneva emphasise the necessity for the Safegu ing of Industries Act and especially for protection of the Dyestuffs Industry.

On the motion of Dr. P. C. C. Isherwo seconded by Mr. N. N. Holden, Mes Feasey & Co., were re-elected Auditors the ensuing year.

The reception of the General Manag report on the Nominations for Council for Group Committees and a vote of the to the Chairman concluded the busines the meeting.

POWDERED FUEL FOR SHIPS.

A Long Distance Test.

The Blue Star liner "Stuartstar," 10 tons, the first English ship to be fitted British plant for burning pulverised f is now on her way to Buenos Aires in o to give the new installation a long-dista test. She will [illegible]

IDENTIFICATION OF OIL-FIELD WATERS BY CHEMICAL ANALYSIS.

By C. E. Reistle.
(U.S.A. Bureau of Mines.)

Introduction.

The petroleum engineer often can correlate underground waters by comparing their chemical characteristics with those of waters previously enconntered in the same locality. In some oil and gas fields the waters found in different strata differ markedly, and the identification of any sample is therefore easy. In other fields, however, different waters may be much alike; then water analyses are of value only if used with caution. In particular, correct methods of reporting and of interpreting the results of analyses must be used, so that all the essential characteristics of the waters will be given due weight and no unessential or misleading information included.

Water in the formations penetrated by an oil well hampers the production of crude oil in many ways. This water may be in the oil sand itself or in separate formations above or below the one that is oil bearing. Water decreases the productiveness of an oil sand, increases lifting costs, and at many wells forms emulsions with the oil. Although it is impossible to eliminate the "edge water" that occurs naturally in the oil sand, it is frequently possible to prevent other waters from entering the productive strata. In order to accomplish this successfully, one usually has to identify the water and locate the stratum from which it is coming.

Identification of the water can sometimes be accomplished by means of dyes or by measurements of its temperature or of its electrical resistance. These methods are not generally applicable, however, and in fact give misleading results. Identification by means of water analysis has proved usually to be the most reliable method. It is true, however, that information based on water analysis is not always infallible, for separate waters occasionally show the same chemical analysis, and sometimes the chemical characteristics of the same water change. It often happens, too, that when separate waters have marked individual characteristics the manner in which the analyses are reported conceals the differences from the petroleum engineer.

Water analysis has long been used in other industries, and systems of reporting that are suitable to the needs of those industries serve the particular industries for which they were designed, but lose their value when applied to others. For example, an analysis to determine the amount of chemical treatment necessary to soften water for boiler use is of little or no value in differentiating between the waters encountered in the production of oil.

Unfortunately, petroleum engineers have too often attempted to use water analyses reported according to an unfit system and have found them of little or no value. This paper discusses present systems of reporting analyses and shows their advantages and disadvantages; it gives actual examples of how waters may be identified.

Occurrence and Circulation of Oil-Field Waters.

The ground waters considered here are restricted to those that may enter oil wells. They generally lie in well-defined beds, or water sauds, which do not differ in texture or mineral composition from other sandy formations or from oil sands. To assume that water and oil sands are essentially different is, therefore, to disregard the principles that govern the accumulation and movement of oil and water.

Water can not flow from a formation unless conditions permit circulation. Various factors influence the movement of water in the sand, such as grain, porosity, hydrostatic pressure, and structural conditions. Water flows most readily through formations of uniformly coarse grain and therefore tends to circulate in the sandy layers, called water sands, that are analogous to the "pay" streaks in oil-bearing formations. Clay and other tight sedimentary beds have a higher porosity than a coarse or porous sand, but the frictional resistance they offer is such that little or no water can flow from them. Although grain and porosity affect circulation, there must be a difference in pressure. The usual source of pressure is hydrostatic and is created by the water entering the bed at a point higher than the outlet. Pressure may in some instances be due to earth pressure exerted on the formations or to gas under pressure, but usually the pressure is hydrostatic, as is evidenced by its increase down the dip.

Formations that seem dry are actually saturated with water, provided they lie below the main water level. These formations, because of their grain, porosity, or low hydrostatic pressure, fail to yield water to a well being drilled, and are therefore

uniform in grain or texture; therefore they yield a flow in one well and do not in a neighbouring well. Frequently the drilling water in the well has head enough to counter-balance or exceed the hydrostatic pressure in the sand, and water may actually flow into the sand from the well. It is possible that water from sands that have a low hydrostatic pressure and have been considered dry may later enter the well after the pressure from the producing sand has declined below that in the water sands.

Nomenclature of Water Sands.

Water sands that lie above the producing oil or gas sand are usually termed "top waters" and those that lie below "bottom waters." Where there are a number of oil or gas-producing sands the waters between the various producing sands are called "intermediate waters." There are also "edge waters," waters in the bottom of the oil sands, and lenticular water sands. These waters are discussed on the following pages.

Top Waters.

When an oil or gas producing stratum is reached by the drill, it is highly important to shut off any top waters from the well. This can best be done by cementing the casing, although often the water can be shut off satisfactorily by the use of mud-laden fluids or by the use of casing shoes in formation shut-offs.

Intermediate Waters.

Intermediate or middle waters are those which occur between sands producing oil or gas. As waters of this type often cause considerable trouble, especially in fields where the wells produce oil from more than one horizon, it is advisable to sample and analyse these waters as the drill passes through them; then they can be catalogued and identified.

Bottom Waters.

Bottom water is the water below the producing horizon. In many fields where only a thin formation separates the bottom water from the producing sand, drilling is carried too far and the well enters the water sand. Bottom water may enter a finished well through a leaky plug even after the well has been repaired. Many wells not drilled into bottom water have been injured by water migrating through the sand from some improperly drilled or repaired well near by.

Characteristics of Oil-Field Waters.

Most of the subsurface waters associated with oil-bearing formations have appreciable quantities of mineral salts in solution. Some waters are completely saturated; that is, they hold a maximum amount of the dissolved salts. Others, such as those encountered in the Rocky Mountain district, carry smaller amounts of salts, although even these waters have a much higher mineral content than ordinary surface waters.

EDUCATION IN RELATION TO INDUSTRIAL ADMINISTRATION.

Federation of British Industries Proposals.

The special committee of the London Area of the Federation of British Industries unanimously approve of the decision of the Education Committee of the Federation that it is now opportune to consider the development of education facilities to cover the subject matter of administration for industry and commerce. It may be that even at this date it is impossible to obtain from general experience any common denominator to form the basis for an exact science, that is, a science of administration. It is, however, quite time that some attempt was made to focus the educational requirements of industrial administration. It is for this purpose that the present report has been drafted with a view to presenting the summarised views as to main features of such courses and certain over-riding conditions.

A very noticeable unanimity is found in the reports of the Balfour Committee on Trade, the Malcolm Committee on Education and Industry and the Emmott Committe who enquired into the position of technical education in relation to industry, as to the vital necessity of the most intimate contact between education and industry in order that the fullest value is obtained from the educational resources of the country in the development of national industry and commerce. It is felt that for further developments in Educational courses to meet Industrial requirement it is very essential that the contact between the Educational Authorities and Industries must be established from the first and it is with this in view that the report is issued to representative Educational Bodies.

Basic Changes in Industrial Organisation.

It must be clearly realised that the conditions pertaining to industry are not static. The development of old industries, the setting up of new industries, the greater mechanicalisation of production, a greater fluidity in the industrial personnel, the great development in the production and use of mechanical power, necessitating new and intensified selling to maintain efficient factory production are some of the ever-changing conditions. These internal changes are supplemented by intensification of competition through the growth of Industry in other countries.

During the last fifty years an industrial revolution has been taking place quite comparable with that covering the break up of the Guild system. This is not the correct place to consider the cause of this revolution but it is essential to consider the results. Perhaps the most striking are :—

(a) The gradual extinction of the personally controlled company which is giving way to the limited liability company;

(b) The merging of operating units into vertical and/or horizontal amalgamations;

(c) The growth of Government control not only of the conditions pertaining to the workers but also of methods of production, etc.

It is plainly evident that the forces affecting industry to-day are therefore very complex and it may be necessary to scrap old methods of control and management in the same way as it has been necessary to scrap old processes due to the development of scientific discovery. This question of the control and management or administration of industry has gradually evolved as a subject of first importance out of the new conditions of industry.

The foregoing remarks must not be taken to suggest that the small privately owned enterprise is doomed to disappear. Conditions will always be found which are very favourable to such units. The provision of adequate educational facilities for those destined to be managers of such businesses is just as necessary as it is for the larger undertakings.

The Science of Administration.

It would be extremely difficult for any two persons to agree what was meant by administration but for the purpose of this report it is considered to cover—

(a) Discovering the best method of carrying out any function concerned with industry.

(b)Ensuring that the method is put into practice.

This simple division suggests two main sides of management problems, the craft side and the art side. The craft side is the side of the expert, hether scientific or commercial; the art side can be regarded as the general administration side in which leadership and the power of blending the various experts into one team, is, perhaps, the most essential characteristic.

America is often regarded as the home of scientific administration of industry. And although much more may have been done in America on a public scale and also in comermcialised development and the training of administration experts, there are factories in other parts of the world in which administration is of as high an order as in the States. It may be that the birth of the movement in the States was due to the difficulties concerned with the labour market as without doubt the development in France by Fayol was due to the poorness of certain mineral deposits. It thus seems that in these two cases we have two of the chief costs in manufacturing, *i.e.*, labour and material, as being the sources from which sprang serious consideration of management as a science.

Principles of Administration.

The above definition of management, namely,

(a) Discovering the best method of carrying out any function concerned with industry;

(b) Ensuring that the method is put into practice,

leads us to a consideration of the main functions of industry, namely, the purchase of something, the doing of work on what is purchased and finally the sale of the manufactured product. To obtain an organisation which will allow these functions to be satisfactorily carried out necessitates finance and the employment of consultants, or one might call it an intelligence service, governing many subjects. In regard to finance many questions arise including ont only the provision of capital but also legal aspects. The organisation once established, adminis-

tration resolves itself into the direction of effort necessary to ensure that the various functions in the buying, manufacturing and distribution sides of the undertaking are being carried out efficiently and that in carrying them out the best practice is being adopted with due consideration of commercial aspects. When one considers the hundreds of varying functions carried out by the personnel of industry it is quite apparent that although there may be some general principles of administration, the actual practice of administration needs the most expert consideration of some one branch of industry or even perhaps an individual works.

It is, however, on the common principles that attention will be focussed and not to the details of study or even of practice as these must be dealt with by particular trade organisations.

REVIEW OF EXISTING FACILITIES.

Universities. The majority of Universities deal with subjects concerned with industrial administration in one or more faculties. Some of the new Universities have developed special courses and even established new degrees such as the Bachelor and Master of Commerce on specialised commercial courses.

Technical Schools and Colleges. Most of these institutions have hitherto been limited to the craft aspect of actual functional work and as such have covered fairly well the field of activity of the foremen and skilled workers. In certain cases efforts have been made to establish courses for foremen, under managers, etc., on some of the principles of administration. In these cases efforts have been made to obtain directional assistance as to the course of studies from those engaged in industry. Of particular interest is the work of the Manchester School of Technology.

Institutions. The institutions are mainly concerned with the first part of the question of administraion, that is, the discovery of the best method of doing some particular technical operation. They might rightly feel that this is the limit of their activity as the field is so vast. This is fairly true of all the institutions but some have of late years definitely opened the door for discussions on administration practice which must be all to the good from the general point of progress. In regard to specialised training of essentially a technical nature much useful service could be performed by the numerous institutions already existing. Some of these institutions are already doing work of national importance and thus influencing the curriculum aspect of those subjects which fall within the field of the institution. Their influence in the majority of cases is thus limited to highly trained personnel, although some carry their work further and act as advisory bodies regarding junior courses. The work of most of these institutions, however, is limited to subjects which have been in the curriculum of schools, colleges and universities for many years, but some of the later institutions such as the Cost and Works Accountants, Institute of Fuel Engineers, etc., have already shown considerable interest in educational aspects of their institution's work. Speaking generally, however, it is safe to say that the voice of industry has been limited to those subjects which are confined to technological operations, that is, the craft of industry.

The Government. During the period of war control the Government instituted a central administration for many industrial activities. Rightly these disappeared as soon as possible.. The various Government Departments to-day are mainly in a technical relation to Industry as is shown in the various specific researches carried on through the Department of Industrial and Scientific Research including trade research associations.

Other Bodies. Various groups of manufacturers and Industrial trade associations have from time to time considered specific problems connected with administration. The general effect of these has, however, been very small from the point of view of directing any serious educational consideration.

SUGGESTED DEVELOPMENT.

The earlier paragraphs outline the position of industry particularly in relation to administration; to show the immensity of the problem and what is being done at present. The following paragraphs contain suggestions for consideration of education authorities providing courses with special bearing on administration practice.

A word of warning must be issued to possible students and to educational authorities providing the courses. Leadership is a personal factor, if it is not present external influences, such as educational facilities, will not provide it. It is realised, however, that modern leadership requires knowledge besides personality; it is to this knowledge that attention must be given. Wherever it

is possible it is strongly advisable that some form of selection of students for courses should be applied as quite apart from the necessary personal equation or the personal characteristics, it must be realised that in the higher ranks of administration, posts are very limited in number. There is, however, a much wider field lower down and perhaps it is for the under-manager type that courses could be best framed.

Problems concerned with purchasing manufacturing and selling have constantly to be faced and it is for the purpose of widening the knowledge and thus limiting the possibility of error in judging as to how these problems are to be solved that administration courses should be directed.

The detailed references under the main headings are general in character. They have been made so deliberately as the requirements of the districts will determine which of the main sections would have to be elaborated and it has to be remembered that the various branches of industry have also their particular requirements. It is considered, however, that the main headings used would cover comprehensively any particular necessity of a district or a trade.

For the higher executive training the courses must be necessarily of a general survey character, but sections could be elaborated for the purpose of meeting the requirements of the specialists and under-managers.

(To be Continued.)

GENERAL NOTES.

TOURISTS IN CANADA.

In the midst of the season when there is the largest influx of visitors into Canada, it is of interest to know that the 1927 tourist season was exceedingly profitable for the country. The Highways Branch of the Department of Railways has estimated that during 1927 such visitors spent about $275,000,000 in Canada as compared with $200,000,000 in 1926 and $140,000,000 in 1924.

The expenditure of tourists from the United States is about fifteen times as large as before the war. About 3,000,000 cars cross the line from the United States during the year, and 8,000 to 10,000 of these cars remain more than a month. Aside from the direct expenditure of these visitors, Canada also receives the less tangible benefit of having her problems better understood abroad.

LONDON THE WORLD'S FINANCIAL CENTRE.

Professor Gregory, of the London School of Economics, produced statistics and arguments to prove that London is still the financial centre of the world. With this viewpoint in mind, he has suggested that the invisible items of the British balance of trade should be a matter of general interest throughout the world. Since the annual British capital surplus at present is only one-fifth as large as in 1911, the analysis of these invisible items would suggest that London bankers are increasing their short time borrowings, decreasing their balances held abroad and using the credits so derived to maintain the volume of long-time investment. This process of "lending long" and "borrowing short" is one that is likely to create difficulties in the near future. In the United States, increased demand for ready money could be met by release of gold, but London is particularly sensitive concerning gold supply and has no large surplus on which to draw.

AUTUMN CAMERA EXHIBITION IN LONDON.

At the conclusion of the recent International Congress of Photography, Dr. Walter Clark reported a week of most interesting and fruitful discussion of the scientific aspects and commercial problems of photography. "Our discussions on these occasions are usually too highly technical to interest the general public," he said, "although few realise the full part that photography plays in the life of the community.

At the exhibition of the Professional Photographers' Association to be held at Princes' Galleries, Piccadilly, London, W.1., in September, there will be a special commercial section illustrating the adaptation of photography to every branch of industry—from selection and grading of raw material, to the marketing of the finished product."

CANADA'S ZINC AND LEAD PRODUCTION, 1927.

According to a Report on the production of zinc in Canada for the year 1927, issued by the Mining, Metallurgical and Chemical branch of the Dominion Bureau of Statistics at Ottawa, a new high record in quantity was established, but owing to the decrease in the price of this metal, the total value of the output was less than in 1926. The 1927 production amounted to

165,405,525 pounds which, when valued at the average London price for the year of 6.194 cents. per pound, was worth $10,250,793. The 1926 output of 149,938,105 pounds valued at the average London price for the year of 7.41 cents. per pound, was worth $11,110,413.

According to finally revised statistics issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa, on the production of lead in Canada during 1927, a new record in quantity was established. The total recovery amounted to 311,423,161 pounds, worth $16,477,139, as compared with 283,801,265 pounds valued at $19,240,661 in 1926.

The greater part of Canada's production was from the Trail smelter, which receives a large proportion of its lead ores from the Sullivan mine at Kimberley, B.C., but which also purchased silver-lead ores from the Kootenay district. The remainder of Canada's production comprised pig lead produced at Galetta, Ontario, lead from lead-ores and concentrates shipped from the Mayo district of the Yukon Territory and from the Tetreault mine in Quebec.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

At the meeting held on Thursday, June 21, the following papers were read in title only :—

The Diffraction of Cathode Rays by Thin Films of Copper, Silver and Tin. By R. IRONSIDE. Communicated by Sir Joseph Thomson, O.M., F.R.S.

In these experiments cathode rays pass through thin metallic films into an exhausted camera and photographs of diffraction pattern are obtained. The metals used are silver, copper and tin, and the range of voltage is from about twenty-five to sixty thousand. The patterns are like those got in X-ray powder analysis, consisting of a series of concentric rings, with modifications. These patterns may be interpreted on the de Broglie hypothesis by considering an electron as a group of waves, and only by this theory has an explanation of the phenomena been derived.

In previous experiments a discrepancy of 6 per cent. was found between the cathode ray and X-ray methods of determining the crystal spacing, but this was due to a systematic experimental error, which has the order of 1 per cent. in the values derived for the lattice constants. Also, according to our theory, the product of the diameter of a given ring in the pattern due to a given metal and the square root of the voltage used in producing it should be constant (except for ½ per cent. relativity correction for each 10,000 volts); the data derived from the experiments satisfy this test. In the patterns due to copper there appear rings which cannot be due to the copper structure; *these are interpreted as being caused by organic matter and by cuprous oxide, the rings due to the oxide growing progressively stronger with the increasing age of the film.*

The Diffraction of Cathode Rays by Thin Celluloid Films. By A. REID. Communicated by Sir Joseph Thomson, O.M., F.R.S.

A series of experiments, suggested by Prof. G. P. Thomson, in which diffraction patterns were obtained by passing electrons through thin celluloid films, is described.

A method of measuring the energy of the rays by their electrostatic deflection is described in detail. The results are in perfect agreement with those obtained by Prof. Thomson, who measured voltages by spark gap.

A probable structure of the films is suggested, and the agreement of experimental results with those predicted by the de Broglie theory indicated.

The Zeeman Effect in the Band spectrum of Helium. By W. E. CURTIS AND W. JEVONS. Communicated by H. C. Plummer, F.R.S.

The Zeeman effects in two regions of the helium band spectrum have been investigated in fields up to 20,000 gauss with an 8-ft concave grating (third order) and a Fabry-Perot 1-cm. étalon. Resolution of the magnetic components has only been effected in one case, but a great many instances of broadening, sometimes quite considerable in amount, have been observed, and some information as to the polarisation of the components has been obtained by means of a double-image prism.

In the case of those bands which are due to transitions between S and P electronic states the results are completely in accordance with theoretical predictions. The effects rapidly decrease in amount (*i.e.*, width of pattern) with increase of rotation, and the polarisation of the outer components is opposite in character for Q and PR type branches.

In the case of another band, details of

a totally different behaviour has been observed. The effects are relatively large throughout both Q and R branches (the P branch being too weak to observe) and they show similar polarisation. The final state of this band is known to be the 2P electronic state of the ortho-He_2 molecule, but the relation of the initial electronic state to the known term sequences of He_2 is not clear. It shows certain other peculiarities besides the exceptional magnetic behaviour.

The Scattering of Cathode Rays. By B. F. J. SCHONLAND. Communicated by Sir Ernest Rutherford, O.M., P.R.S.

It is shown that the writer's recent cathode-ray scattering experiments were not suitable as an adequate test of the relativity correction to the orbit of a β-particle deflected by an atomic nucleus, owing to the effect of radiation and of the spiral form the orbit may take. A full treatment of the effect of the relativity orbits is given and an estimate is made of the amount of scattering to be expected, which is in fair agreement with that observed.

The Energy of a Body Moving in an Infinite Fluid, with an Application to Airships. By G. I. TAYLOR, F.R.S.

It is shown that the energy in the fluid surrounding a body which moves without rotation in an infinite fluid depends only on the terms of the first degree in the spherical harmonic series for the velocity potential. Conversely, these terms are completely determined when the expression is known which represents the energy of the flow in terms of the components of velocity of the body.

As an application of these results a simple formula is developed giving the virtual addition to mass associated with a body moving with a uniform acceleration through a fluid in terms of the equivalent distribution of sources and sinks which give rise to the same external flow. The virtual mass associated with a particular airship shape, discussed by Fuhrmann, is calculated.

SOCIETY OF GLASS TECHNOLOGY.

THE INTERNATIONAL MEETING AT AACHEN.

The last meeting of the session of the Society of Glass Technology, namely, that on June 28, was devoted mainly to reports of the proceedings of the recent Joint Meeting at Aachen between the Society of Glass Technology and the Deutsche Glastechnische Gesellschaft.

This meeting, which was stated to have been the first occasion in which a British and a German scientific society had met on German soil since the war, occupied three days, namely, May 22-24, and was marked by very generous hospitality on the part of the civic authorities and prominent local glass manufacturers, particularly of Messrs. Bicheroux and of the Stolberg Works of the St. Gobain Company.

The technical proceedings occupied two days. The first was devoted to Joint Committee work, presided over, the first part by Prof. G. Gehloff, Vice-President of the Deutsch Glastechnische Gesellschaft, the second part by Prof. W. E. S. Turner. Questions of methods and standards were the subject of consideration in three fields of glass technology, namely (1) the physical and chemical measurements on glass with special reference to the subjects of thermal expansion, viscosity and chemical durability, (2) the physical properties of glasses suitable for manipulation by automatic machinery and (3) modern developments in refractory materials suitable for the glass industry.

The leading contributors who presented considered reports to the discussion on section 1 were Dr. M. Thomas for the German Society; for section 2 Mr. F. W. Adams and Prof. Gehlhoff; for section 3, Mr. W. J. Rees and Dr. W. Miehr.

After the proceedings in Committee it was decided that a Standing Committee composed of representatives of each of the two Socities should be appointed to continue the discussion of the proposals formulated during the day and make recommendations in regard to standards.

May 23, was devoted to an 8-hour sitting for the reading and general discussion of papers. Four were read on behalf of members of the Deutsche Glastechnische Gesellschaft, and four by members of the Society of Glass Technology, the papers being read as follows :—

"The Glass Melting Furnace as a Heat Engine" by Prof. Dr. D. Aufhauser, Hamburg.

"The Thermal Expansion of Glass and the Question of the Determination of Annealing Temperature" by Prof. W. E. S. Turner, Sheffield.

"The Velocity of Crystallisation of Soda-Lime-Silica Glasses" by Prof. Dr. E. Zschimmer, Karlsruhe.

"Expansion and Tensile Tests on Glass House Refractories" by J. F. Hyslop, R. F. Proctor and H. C. Biggs, Research Laboratories of the General Electric Co., Ltd., (to be presented by Mr. B. P. Dudding.)

"The Physical Properties of Clays" by Prof. Dr. G. Gehlhoff, Berlin.

"The Influence of Cullet in Glass-Making Operations by Prof. W. E. S. Turner, Sheffield.

"The Amount of Gases and of Water contained in Glasses" by Dr. Ing. H. Salmang, Aachen.

"*The Annealing of Glass from the Point* of View of Factory Operation" by E. A. Goad-Pryor, London.

Thursday, May 24, was devoted to visits to the large Plate Glass works at Stolberg (St. Gobain, Chaucy and Cirey) and to Herzogenrath (Messrs. Bicheroux and Co., Ltd.

Nearly 60 British members of the Society of Glass Technology made the journey to Aachen and about 50 of these prior to the meeting carried out a series of visits to works and institutions at Berlin, Weisswasser, Dresden, Brockwitz, Hohenbocka, Frankfurt, Karlsruhe, Saarbrucken (St. Ingbert), Cologne and Essen. A number of members of the Society of Glass Technology resident in Holland, Belgium, France and Spain also attended the meeting at Aachen.

Visit of The American Ceramic Society to England.

In response to the joint invitation of the English Ceramic Society and the Society of Glass Technology the American Ceramic Society has recently paid a successful visit to this country.

Some 70 odd members and friends arrived in London on June 21, after making a tour through France, Switzerland, Czecho-Slovakia, Germany and Holland. They were received in London by the President and Secretary of the English Ceramic Society and the President and Secretary of the Society of Glass Technology. The National Federation of Clay Industries was also actively associated with the reception and banquet in London and the Refractories Association joined with the Society of Glass Technology in receiving and entertaining the visitors at Sheffield. At Stoke, the British Pottery Manufacturers Federation entertained the visitors to dinner and the Ceramic Society to luncheon on Wednesday, June 27.

Except that a few members of the party attended the opening meeting of the new section of the English Ceramic Society to be devoted to the heavy clay products, the visit was occupied wholly with a round of visitations to works and of social functions. In London and district visits were paid to Messrs. James Powell & Sons (Whitefriars) Ltd., Wealdstone, Harrow, the General and Glass Works at Wembley, and the Rockware Glass Syndicate, Ltd., at Greenford. Subsequently those interested in glass were taken to Stourbridge to visit the works of Messrs. Stevens and Williams, Ltd., Stourbridge, travelling on thence by way of Stoke to Sheffield, where they spent two days. One half day was devoted to seeing the Department of Glass Technology, Sheffield, and on the following day visits were paid to Messrs. Beatson, Clark & Co., Ltd., Rotherham, Messrs. Wood Bros. Glass Co., Ltd., Barnsley, Messrs. Redfearn Bros., Ltd., Barnsley, Messrs. John Lumb & Co., Ltd., Castleford, and Messrs. Hailwood & Ackroyd, Ltd., Morley. A large number of the party went to Pillinge to see the large brick-making plant of the London Brick Company and Forders, Ltd. Several who were interested in China clays visited St. Austell, whilst other visits were paid to the Royal Worcester Porcelain Company, the fireclay works of Messrs. E. J. & J. Pearson, Stourbridge, a number of factories at Stoke-on-Trent, and to the County Potteries laboratory at Stoke. Subsequently those interested in refractory materials visited the works of the Derbyshire Silica Co., Ltd., Friden. Other visits in the neighbourhood were paid to Messrs. Pearson's Potteries, Whittington Moor, The Oughtibridge Silica Firebrick Co., and the Leeds Fireclay Company. The visitors left our shores with very sincere expressions that the English Ceramic Society and the Society of Glass Technology would very soon pay a return visit to America.

ASTRONOMY AND COSMOGONY.

This is the title of a new work by Sir James H. Jeans, M.A., D.Sc., LL.D., F.R.S. Pp. x + 420. Royal 8vo. Price 31s. 6d. net. Cambridge: The University Press. 1928.

This book describes the present position of cosmogony and the facts of astronomy and physics related thereto. Sir James Jeans gives a remarkably clear presentation avoiding technicalities as much as possible or otherwise explaining them. There is of necessity a substantial amount of mathematical analysis, but the book in other respects is quite easy to read as the author has balanced his mathematics with non-mathematical language and introduced summaries where necessary.

The Contents may be quoted here:—Astronomical survey of the universe; light from the stars; gaseous stars; source of

stars; non-spherical masses — dynamical principles; configurations of rotating liquid masses; configurations of rotating compressible masses; rotation and fission of stars; evolution of binary systems; ages of stars; great nebulæ; galactic system of stars; variable stars; solar system; conclusion; subject and name indexes; 16 plates of illustrations (actually 40 half-tone-block illustrations). There are 63 Figs. and about 37 Tables.

It will be remembered that Dr. Jeans had given us a work of a similar nature* in 1917 dealing with the evolution of the heavenly bodies, and a small book (2s. 6d.) on ATOMICITY AND QUANTA—the atom plays a prominent part in all astrophysical phenomena.

While some of the earlier ideas as expounded in the former book have been retained and expanded the author thought best to give an entirely new presentation. This is to be expected as science is being enriched by new discoveries that follow in rapid succession. In fact book writing becomes an increasingly difficult task on this account.

Surveying the Universe. — This book opens with a discussion of certain magnitudes. The moon which is our nearest neighbour is about 240,000 miles from the earth, while the farthest astronomical objects are so distant from us that their light takes over one hundred million years to reach the earth—140 millions may be taken as a fairly recent estimate.

The heavenly bodies have been classified as common stars, binary stars, variable stars, star-clusters, spiral nebulæ, etc. The present writer may remark that it is the *classification and study of these objects*—made possible by large telescopes with spectroscopic attachments, etc., and the great labour of astronomers and instrument makers—that have led to the discovery of many secrets of the stellar universe, aided of course, by mathematical equipment; and, to pass backwards in time, the formation of the solar system by the chance passage of a star is revealed as a probability.

On page 8 curves are shown giving the density distribution of stars as measured from the sun. The curve drops towards the zero line as the distance from the sun increases, this being partly due to very faint stars not being seen, yet this density near to the sun could not continue for then the whole heavens would be luminous. Stars nearest to the sun are scattered at the rate of one every 10 cubic parsecs. There is, however, an enormous gap between the sun and the nearest star, Proxima Centauri, at a distance of 25,000,000 million miles. We seem to be roughly in the centre of a much flattened spheroid of stars—in the middle of things—which thins out towards its periphery and outside this huge galactic system, as it is called, there are extra-galactic nebulæ. The great nebula M31 in Andromeda is almost comparable in size with the galactic system, being roughly half its diameter. This is depicted by a diagram.

Dr. Jeans *says:* "A simple scale model may help us to visualise the vastness of the gulf which divides the planets from the stars. If we represent the earth's orbit by a circle the size of the full stop of the type used in this book . . . the sun becomes an entirely invisible speck of dust and the earth an ultra-microscopic particle a millionth of an inch in diameter. On this same scale the distance of the nearest star, Proxima Centauri, is about 75 yards, while that of Sirius [the brightest star in the sky] is about 150 yards." *On this scale* the furthest object, as mentioned above, is at a distance of about a million miles. Jeans, appropriately says: "The inhabitant of the earth may well pause to consider the possible objective importance of this speck of dust to the scheme of the universe as a whole." *Passing on to the system of the* great nebulæ, Jeans says: "We can construct an imaginary model of the system of the great nebulæ by taking about 50 tons of biscuits and spreading them so as to fill a sphere of a mile radius, thus spacing them at about 25 yards apart. The sphere represents the range of vision of the 100-inch telescope; each biscuit represents a great nebula of some 4,000 parsecs diameter [one parsec = 3.083×10^{18} cms. = 2.529 light-years]. A few nebulæ of exceptional size must be represented by articles rather larger than biscuits, while our system of stars, up to Kapteyn's tenth spheroid, would be represented by a flat cake 18 inches in diameter and 2½ inches in thickness. On this scale the earth is far below the limits either of vision or even of imagination. *It is a little more than an electron* in one of the atoms in our model; and we should have to multiply its dimensions many millions of times to bring it up to the size of even the smallest particles which are visible in the most powerful microscopes." Thus it will be seen that we have surveyed the universe and brought it down to com-

* PROBLEMS OF COSMOGONY AND STELLAR

Star Models.—Chapter VI deals with an ideal model of a gaseous star. When stars are born out of a gaseous nebula they are wholly gaseous, but condensation takes place and they become more and more dense towards their centres as time goes on until they reach a liquid state, their outer envelopes being still gaseous. Considering ordinary stars, such as our own, which emit internally X-radiation (X-rays), this radiation would be absorbed in the outer layers of gas or matter of the star. It would be transformed and issue as temperature radiation. If such stars were entirely gaseous, as was generally supposed, the equilibrium conditions which must obtain lead to serious difficulties. In 1923 Kramers investigated the absorption of X-rays in matter. Arising therefrom "the whole build of a star depends on the value of the opacity coefficient *k*." This determines the absorption of radiation generated (which generation will be discussed presently) and from the star's structure N^2/A, the former letter being the atomic number and the latter the atomic weight. All this comes out quite clearly when Emden's density distribution is taken into account. If the stability is obtained by the star being highly condensed towards its centre, then applying Boyle's law in connection with the other factors here mentioned, the atomic weight of the elements comes far too high—outside the range of all possibility. Or, stating this another way, assuming Boyle's law to obtain throughout the star, the observed opacity of the atoms for stopping radiation demands an impossibly high atomic weight, to use Jeans' words. If, however, Boyle's law does not apply to the central parts of stars when they are liquid the atomic weight comes out still high but within the range of possibility, namely, a little over uranium, so that the atomic number would be in the neighbourhood of 95. The lighter atoms float in the gaseous matter surrounding the star's nucleus.

Evolution of Liquid Stars.—A star may have many atoms highly ionised, that is to say, stripped of their external electrons. A star composed of fully stripped atoms, *i.e.*, of only bare nuclei, should not radiate any energy, or a very little at any rate. The white dwarfs approach to this state and their atoms would be far closer together in consequence of the stripping. This means that the star would be of small diameter but very dense like the white dwarf companion of Sirius. Jeans says: "The evolution of the stars must no longer be compared to the steady march of an army through a perfectly flat featureless plain, but rather to the movements of an army scrambling down, and possibly at times up, a succession of terraces. The different terraces are the bands of stable configurations which correspond to the jamming of atoms ionised down to different rings of electrons [see books on atomic structure]. A star stands for a time on the terrace corresponding to one ring, and then, stepping on to the slippery unstable region between this terrace and the next, drops down to the next lower terrace—from the giant branch to the main sequence, let us say. Apart from the considerations advanced in . . . , which we shall disregard for the moment and return to later, the lowest terrace of all, the main sequence, does not lead to a further drop down. It is not bounded on its further side by a slippery unstable slope but by an impenetrable barrier formed by configurations in which the atoms lie as close together as they can be packed. In course of time most stars reach this barrier but cannot cross it, and sidle along it indefinitely. This explains the great concentration of stars along the left-hand edge of the main sequence, against which the stars seem to press like flies agaiust a window-pane." Leaving fission (arising from a star having more angular momentum than it can sustain without bursting) out of account here, the quotation may be continued. "For the sake of simplicity in exposition, we have spoken of the left-hand edge of the main sequence as forming an impenetrable barrier. Actually, as we have seen the barrier is not absolutely impenetrable. The more a star presses against the barrier the greater (in general terms) becomes the density at the star's centre and the consequent deviations from the gas daws. We have seen . . . that when the deviations from the gas-laws become sufficiently great the barrier is no longer impenetrable. If the star presses sufficiently hard against the barrier a door suddenly opens, the star falls through to a still lower, and very much lower terrace, and finally regains stability as a white dwarf. In a white dwarf the great majority of the atoms are stripped bare down to their nuclei and so are immune from annihilation and have almost no capacity for generating radiation. As a consequence stars on the white dwarf terrace are only very feebly luminous, and the fall to the white dwarf branch is the end of a star's career as a briliant luminary. It is slightly disconcerting to find that our sun's position in the temperature-luminosity diagram suggests

that it is pressing with perilous force against the dangerous edge of the main sequence, so that its collapse into a feebly luminous white dwarf may commence at any moment." This portends the end of the world, but see p. 410 for some reassurance. At any rate this is the possibility that must be faced. If the writer understands correctly there are unknown conditions, but theory predicts this startling possibility.

Source of Stellar Energy.—A square centimetre of the sun's surface " emits sufficient energy to drive an eight-horse-power engine continuously." The output from an *O* or *B* type of star, such as Plaskett's star, is 200 times greater. Newton, OPTICS (1704), suggested " the changing of bodies into light and light into bodies," and he refers to this as " very conformable to the course of Nature, which seems delighted with transmutations." Jeans (*Nature*, 1904, LXX, 101), had pointed out " that an enormous store of energy could be derived out of the total annihilation of matter, positive and negative charges rushing together and neutralising and so annihilating one another, the resulting energy being set free as radiation." In 1918 Jeans' " calculated the amount of energy which would thus be set free and the length of life which this source of energy allotted to the stars." Perrin followed up this idea in 1919 as applied to hydrogen combining and forming helium, in which case the residual loss of atomic weight, now known to be theoretically 0.029 (on the mass scale of the unit being a sixteenth of the mass of oxygen taken at 16 exactly), would transform into radiation.

In 1905 " Einstein shewed it to be a general consequence of the theory of relativity that a change of energy δE in any system involved a change in its mass equal to $\delta E/C^2$. Thus the emission of radiation by a star or any other body at a rate E ergs per second necessarily involves a loss to the mass of the radiating body at the rate of E/C^2 grammes per second. The sun's present radiation of 3.8×10^{33} ergs per second involves a diminution of the sun's mass at the rate of $1/C^2(3.8 \times 10^{33})$ grammes a second . . . the sun's mass diminishing at the rate of 4.2×10^{12} grammes per second, or about 4 million tons a second."

If protons and electrons combine so closely as to neutralise one another then the energy given out is the masses of these two entities added together and multiplied by the square of the velocity of light (C^2). The energy contained in matter is thus enormous. Jeans says : " Some 8,000 tons of oil must be burnt to drive a liner across the Atlantic; the same amount of energy could be provided by the annihilation of about one-eightieth of an ounce of oil."*

The result of so simple a theory is that the universe is slowly dissolving up to a certain point into radiation, the above annihilation of matter causing the stars' radiation.

In this connection the higbly pentrating radiation in the earth's atmosphere as found by McLennan, Burton, Cook, Rutherford, Kolhörster, Millikan and others is thought to arise from this process taking place in the far distant and widely scattered nebulæ.

Origin of the Solar System.—It is not necessary to refer to this at length as the article already exceeds its proper limit. The passage of a wandering star fairly close to our sun set up tidal action and jets of matter were drawn out which broke up and condensed into the planets, these in turn having thrown off, by a similar process, their satellites. " Condensed into " here means formed by the coalescence or rounding up of drops or detached masses, as well as passing from the gaseous to the liquid state, gravity acting to consolidate the matter. The conditions evidently varied, some planets being born liquid while others were born gaseous. A combination of both states would be possible in some cases.

The earth and planets were formed from the outermost layers of the sun, hence they may not have any atoms of exceptionally high atomic weight.

Plate XVI, opposite page 397, shows nebulæ suggestive of tidal action, these being : N.G.C. 5278-9, and N.G.C. 4395-4401.

The titles to the sections above are partly the present writer's. Many more features than here touched upon will be found of absorbing interest, and every reader of scientific literature shonld become possessed of a copy of this great book.

F. H. L.

* If the sun should fail us (see above), by that time man may be able to tap this reservoir of energy and get on quite comfortably without the sun's radiation.—REVIEWER.

New Patents.

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Latest Patent Applications.

21,285.—Adcock, P., Baguley, N. G., Courtaulds, Ltd., and Wilson, D. L. — Manufacture of anhydrous sodium acetate. July 23rd.

21,738.—Bogdandy, S. von. — Manufacture of chlorine derivatives of organic compounds. July 26th.

21,602.—British Thomson-Houston Co., Ltd.—Cellular silica product. July 25th.

21,624.—Gasverarbeitungs Ges.—Production of hydrogen. July 25th.

21,594.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of condensation products of anthraquinone. July 25th.

Specifications Published.

267,901.—Kunstharzfabrik Dr. F. Pollak Ges.—Manufacture of phenol-formaldehyde condensation products.

294,284.—British Dyestuffs Corporation, Ltd., and Brightman, R.—Azo dyestuffs and their application.

272,967.—I. G. Farbenindustrie Akt.-Ges.—Manufacture and production of aliphatic and hydroaromatic sulphonic acids.

The Latest Trade Marks

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491,545.—Chemical substances prepared for use in medicine and pharmacy.—Alexander Finlay, Ltd., Soap, Candle and Glycerine Works, Victoria Square, Belfast. August 1st.

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YALNIF.

491,544.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Alexander Finlay, Ltd., Soap, Candle and Glycerine Works, Victoria Square, Belfast. August 1st.

PO-HO.

489,086.—Chemical substances prepared for use in medicine and pharmacy, but not including inhalers.—The Firm trading as Po-Ho Sanitats-Werk Hamburg Otto Joh. Jul. Witt and Söhne, 100, Hasselbrook Strasse, Hamburg, Germany. August 1st.

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IS NATURE CONTRADICTORY.

By DR. W. TOMBROCK.

Ether must exist.

Even Einstein acknowledges this:—"D'après la théorie de la relativité générale, l'espace est doué de propriétés physiques; dane ce sens, par conséquent, *un éther existe . . . un espace sans éther est inconcevable* . . . Cet éther ne doit pas être conçu comme étant constitué de parties pouvant être suivies dans le temps; *la notion de mouvement ne doit pas lui être appliquée*." (Einstein: L'ether et la théorie de la Relativité. Conférence faite à l'Université de Leyde le 5 Mai 1920. trad. fr. 1921.)

Thus the ether must exist since indeed the light is propagated therein . . . *space without ether is incomprehensible* . . . but *the concept of motion is not applicable to it*, thus, *the light is propagated without motion in the ether;* this unmistakeably correct conclusion from the argument is contradictory.

Now Bridgman puts emission and reception of the light as simultaneous (Bridgman: "The Logic of Modern Physics," 1927). But the velocity of light has been measured experimentally; emission *must* preceed reception . . . the simultaneity here proposed is thus contradictory.

Tummers has shown that a contradiction exists between two of the proposed fundamental principles of a modern physical theory (Tummers: "Die spezielle Relativitätstheorie Einsteins und die Logik." 1924).

Weber wrote as follows: "Die exakteste aller Wissenschaften, die Mathematik, führt uns mit ihren *widerspruchsvollen* unendlichen Gröszen mitten hinein ins Metaphysische. Da setzen wir ein und wie von selbst, im Grundgedanken ureinfach, entrollt sich das gesuchte einheitliche mit den Erfahrungstatsachen übereinstimmende Bild der materiellen Welt mit einem in seinen weiteren Folgen unabsehbaren Einblick in das Wesen der Materie." Expressed more shortly: Weber seeks the explanation of modern physical contradictions in the region, which according to him is rich in contradictions, of the mathematically infinite quantities. "Demgemäsz wird der Versuch unternommen die letzten endlichen Eigenschaften und Urstoffe unmittelbar aus dem Unendlichen abzuleiten und so den Schlüssel zu finden, mit dem eine einfache einheitliche und widerspruchslose

Ableitung der als allgemeine Gesetze erscheinenden Erfahrungstatsachen der Physik und Chemie möglich ist." Weber wants to seek an explanation, which contains no contradictions, with the aid of the mathematical infinity, which according to Weber, actually contains contradictions. "Wenn Widersprüche zu erklären sind, so darf die Mathematik dies nicht mit ihren endlichen doch nur eindeutigen Gröszen tun, sondern nur mit der Grösze, in der bei ihr *widerspruchsvolle* Eigenschaftenvorkommen, das ist das mathematische Unendliche." (Weber: "Das Wesen der Materie und der Aufbau der Atome." 1927.)

It cannot be put more strongly; Weber here proclaims contradiction as an exact mathematico-physical, fundamental principle.

Contradiction involves impossibility and that which is impossible cannot exist in reality. Modern physical contradictions thus cannot lie in the real material world; they are thus themselves not real but apparent and have their origin in the present-day physical theories and material hypotheses. Faulty reasoning, incorrectly applied or interpreted mathematics, but especially faulty first principles (premises) must be the cause of these contradictions.

In the time, which preceded Bacon and Locke, natural philosophy was in a state of decay, because too much importance was attached to casuistic reasoning. People were of opinion that everything could be explained *merely* by reasoning (Bacon: Novum Organum). Is now the study of nature, in particular, physics, in a state of decay because, at the present day, too much is expected from a mathematical treatment of the problems?

Note: Einstein's *ether, to which the concept of movement is not applicable*. Bridgman's simultaneous emission and reception of light. Weber's fundamental contradiction . . .

And again: Contradiction involves impossibility and that which is impossible cannot be real.

Now two sorts of ways of looking at all this are possible. Either the theorist says: "I cannot make a mistake," and he accepts the contradiction as fundamental—as Weber does. Or the logician says: "I must have made a mistake somewhere or other, in this case, probably in my fundamental material hypotheses."

Everyone, who merely knows something of the history of natural sciences, will acknowledge that sources of error exist. We have already pointed out some of these sources incidentally. The postulated continuity of the ether is a source of error when it is true that two material particles cannot occupy the same place at the same time. The setting of the problem of the phenomenon of light can become a source of error if one assumes that emission excludes undulation. Confusion of matter with energy. Indistinct insight into what must be assumed as real and what as apparent in mass . . . source of error. The assumption of attraction and repulsion of electrons and protons by themselves is the postulation of an incomprehensibility, which again leads to incomprehensibilities, not to say contradictions arising from this.

But now what must all this signify?

What is our object, what is the object of the study of nature?

To arrive at an *understandable* explanation of material properties and phenomena? or not?

But a categorically logical formulation of an understandable, acceptable, fundamental material hypothesis is then indispensable.

What is matter?

Matter is the substratum of all physics.

What do we attribute fundamentally to this?

That two material particles *cannot* occupy the same place at the same time.

What follows?

The ether must consist of particles, otherwise motion in the ether is impossible.

If now we distinguish between the material particles through their volume and type of motion (protons, elctrons and ether-particles) we arrive by way of our modern empirical physical knowledge practically spontaneously at explanations of gravitation, electricity, magnetism and so on, which in any case can be called logical and, at any rate on superficial consideration, are understandable and give a modern, possibly eternal, clearly drawn picture of the ancient παντα ρει.

SUMMARY.

1. A simple fundamental hypothesis is given concerning the structure of matter (*Chemical News*, 1928, cxxxvi, 193).

2. With the aid of this hypothesis a simple, obvious, though as yet superficial, explanation is given of some general material properties and phenomena (*ibid*, 289).

3. A consideration of the concept of mass and the laws of the conservation of matter

and of energy going with the above-mentioned hypothesis (*ibid.*, 337).

4. Attention is drawn to an uncorrect, at any rate unsuccessful, statement of the problem of a universal physical phenomenon, made from the beginning of our physical thought up to the present time. It is mentioned in passing that this statement of the problems is avoided by our hypothesis (*ibid.*, CXXXVII, 1 and 66.)

5. Some noteworthy contradictions, going with the above-mentioned fundamental—unsuccessful—physical statement of problem, are given.

May, 1928.

EPILOGUE.

Deduction and induction are usually regarded as opposites. The derivation of the special from the general (mathematics, logic), is termed deductive; the derivation of the general from the special is termed inductive (empirical subjects. Bacon and Locke were masters of the inductive method.

Now the question occurs : " Is the fundamental hypothesis of matter which we have been considering inductive or deductive? " I have been reproached with this hypothesis being *too* hypothetical!

Whoever will reflect will see that this latter reproach is unfounded. Indeed, by deleting some material properties from separate ultimate particles our idea of the material world becomes precisely less hypothetical. We indeed attribute gravitation and positive and negative electricity only to complexes of material particles to which we may do so authoritatively through observation and we thereby avoid the illogical generalisation of attributing the above-mentioned properties to the separate particles. And the attribution of these properties to the separate particles can only happen as an hypothesis, since it is unauthorised and illogical as a generalisation. As a result of this our conception of matter is definitely less hypothetical than the customary conception in which a positive or negative charge respectively is attributed to the proton and the electron.

Again the standpoint of those who, in pretending to be as little hypothetical as possible, would leave open the possibility that ether may differ *essentially* from matter, is yet nevertheless hypothetical in that the ether has totally immaterial and, hence for us, incomprehensible properties. Their standpoint may certainly not be called less hypothetical than mine. On the contrary, I believe that this question is here conceived in as simple — as little hypothetical — a manner as possible. As a result of this it appears that the other standpoint that attributes incomprehensible properties also to the ether, is contrary to the purpose of science—the giving of understandable explanations.

But must our hypothesis be called inductive or deductive?

The definition : matter is the substrate of all physics—is all that which moves—is free and indisputable.

The fundamental premise : " two material particles cannot simultaneously occupy the same place " to which premise the law of the conservation of matter is directly connected, is, as far as the ultimate material particles are concerned, incapable of proof or refutation—and though we might appeal to macrocosmical empirism—this proposition is an axiom.

In so far our hypothesis is thus deductive (as for example mathematics). We may point out, however, that this hypothesis actually—implicitly—serves as the basis of all physics and chemistry—indeed how otherwise would collision be possible? and that then these subjects, which one usually terms inductive, are also in this far deductive.

One thus sees that a sharp distinction between deduction and induction is very difficult if not impossible. Besides after further development mathematics becomes an element in inductive science and mathematics is deductive—thus once more amalgamation. If now one will call my hypothesis deductive, one is correct but one must not forget that really no exact scientific subject is purely inductive.

If one develops further the above-mentioned explanation of matter and deduces from the premised protons and electrons (ether-particles) with their characteristic forms of motion the known properties and phenomena of nature, then one is entirely in an inductive (borrowed from experience) region. Sharp limits between induction and deduction cannot thus be drawn in this case.

And indeed can deduction and induction really be completely separated in general? Do not the first principles, the axioms of mathematics, the fundamental propositions, the premises of the deductive systems in their turn again rest on empirical experience, on inductive ground therefore? So that deduction and induction rather form a closed chain than that they stand apart. And the basis of everything—our observation—is inductive? Nil est in intellectu quod non priusquam erat in sensu . . .

which the admirer of our so-called exact sciences sometimes loses sight of. Moreover that induction is more certain than deduction will also not do; mathematics is indeed deductive and it can least of all be termed uncertain. And although exact science is also firstly and mostly inductive yet deduction and induction go therein hand in hand, just as experiment and hypothesis, forming a practically illimitable series . . . whilst without logic there can be no chemistry.

"But there is no mathematics in it."

Certainly not. Put it in then. Put the theoretical horse in your mathematical harness. This cannot be and need not be. Need it not be? *Nolens volens* you do it for all that. In any case it is necessary for you first of all to assume a theoretical foundation logically built up. Otherwise with all your mathematics you will produce nothing right—nothing of an understandable explanation of nature I mean. Do you deny this? Then read "Is Nature contradictory?" just once more. That is what it ends in when you work without a logical foundation.

But if one wants to know what name can be given to my explanation of matter as regards its theoretical foundation—in distinction to the wellknown physico-mathematical theories, I would answer: chemical. This kind of theory-building is chemical.

July, 1928.

Bergen op Zoom,
Holland.

SCIENTIFIC FOUNDATIONS OF THE REFINING OF PETROLEUM.

By A. E. Dunstan, D.Sc. (London), F.I.C., F.C.S.

(*Introducton to Cantor Lectures.*)

Gas and Gasoline.

(Delivered before the Royal Society of Arts, January, 1928.)

It is of more than passing interest to realise that the late Sir Boverton Redwood delivered the Cantor Lectures in this historic hall so long ago as 1886. He took as his subject Petroleum and its products, and in the compass of four hours he dealt in a masterly and exhaustive way with this great theme. How impossible to do it justice to-day in such a period of time! Forty years ago we find the eminent lecturer delving into the records of antiquity and summarising the early history of petroleum and developing his subject to the beginning of our own generation, discussing the general geology of petroliferous formations and proceeding to the chemical and physical characteristics of mineral oil as they were then known. He described in considerable detail the method of winning oil as practised by the ancients and by more modern methods — methods that have changed singularly little since 1886. Transport of the raw material from the field to the refinery is to-day much as it was in those early days, but it is on referring to the last two lectures that we realise the tremendous progress that has been made in four decades. In these lectures the author discussed the refining and application of petroleum. Distillation at that period was merely the boiling of oil and the condensation of its vapours, with little or no attempt at fractionation, whilst refining was, in effect, a more or less brutal attack by means of strong sulphuric acid. There are, however, indications of methods that foreshadow modern development, and an outstanding case is the reference to the "cracking" of heavy hydrocarbons as practised at Nobel's refinery at Baku, whereby good yields of aromatic compounds were obtained. Very significant is the statement that "by far the most important of the uses to which the products of petroleum are as yet applied is that of illumination." In an eloquent epilogue the lecturer emphasised the claims of petroleum to have been a potent civilising influence, and suggested that "the degree of mental culture of a nation may be measured by the quantity of mineral oil consumed."

Not only was it true that in the late war the "Allies floated to victory upon a sea of oil," but, also, it is equally true to-day that our everyday life depends for its existence, its amenities and its luxuries upon petroleum. Twenty-five million motor vehicles of all sorts not only transport ourselves, but our food and our raw materials. Civil and military aviation make an ever-increasing demand on mineral oil, whilst the great navies of the world would lose their wide radius of action did they not function on liquid fuel. Yet, as Sir John Cadman has justly remarked, "it is reasonably safe to predict that the "to-morrow" of petroleum (using the word in its most comprehensive sense) will far outshine even the brilliance that to-day attends its achievement. . . . Remarkable as may have been the use of oil during the last fifteen years, there are indications that by the development of new processes and of more economical methods we shall shortly enter upon a much more scientific phase in the use of oil."

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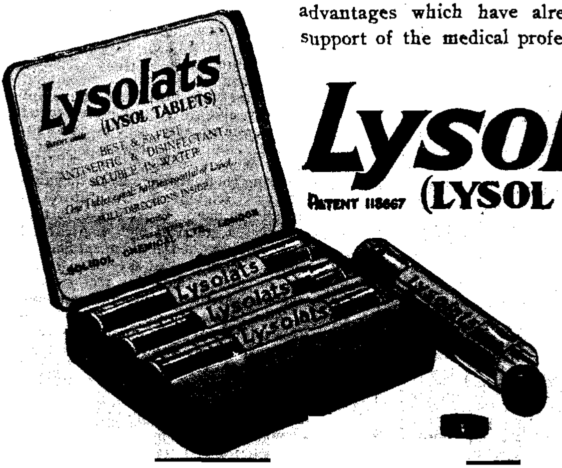

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A LOOK BACKWARD.

By The Late Edgar F. Smith,
University of Pennsylvania, Philadelphia, Pennsylvania.

(*Abstracted from the Journal of Chemical Education, Vol. 4, No. 12. December, 1927.*)

Having lectured on the history of chemistry to undergraduate and graduate students in chemistry, the writer confessed to himself on more than one occasion that American chemists had received scant attention from him. Was there a history of chemistry in America comparable to that which had been so fully outlined for other countries?

Where was this information to be obtained? Probably in the earliest American publications. Where were these printed? In the end the search was carried to Philadelphia, which for a hundred years had been the seat of the ripest culture in America. The best libraries existed there. And

Just by St. Paul's, where dry Divines rehearse,
Bell keeps his store for vending prose and verse,
And books that's neither. . . .

Particularly was Philadelphia the center of publications of chemical literature.

As early as 1771 Benjamin Rush, a medical man with a decided preference for chemistry, issued a brochure on the subject for his students. He had been a pupil of Joseph Black, a most inspiring teacher, who made chemistry of consequence in the minds of his students. Rush was in this group. He never could cast aside his chemistry, enthusiast though he was in medicine. Hence, he emphasised it in his teaching, which began in 1769 in Philadelphia. He turned the attention of many young medical men to chemistry. Whether this was purposely done has never been determined. But he did it, and chemists of the present should be the last to reproach him for so doing. He was the first professor of chemistry in any American college or university. His brochure was one of our earliest chemical textbooks. He also wrote an exhaustive paper on the analysis of water. One smiles at much of it, but in its pioneer character it had a definite value.

It is as an enthusiastic, inspiring teacher that chemists of America are under obligations to Dr. Rush. He knew the worth of research, though in chemistry he produced nothing of value. He held an A.B. from Princeton and an M.D. from Edinburgh. He was a scholar with a fondness also for public affairs, which may be inferred from the fact that he signed the Declaration of Independence.

Many of his medical pupils gave themselves entirely to chemistry after winning the coveted medical doctorate. Among these one individual in particular deserves thanks for the splendid things be did. This was James Woodhouse (1771-1809), who had won his A.B. and M.D. from the University of Pennsylvania. In his student days, so thoroughly interested had he become, that numerous papers on chemical subjects came from his pen. They had met the approval of Rush. Indeed, Woodhouse founded in 1792 the Chemical Society of Philadelphia, most members of which were young men, possessing a common inspiration and love—chemistry.

They sought also to make chemistry of service to their country. An examination of their minutes will show how genuinely active they were. They were not dilettante. They were thoroughly conversant with the chemistry of that day and their object was to use it in all possible was. It was this society which organised a laboratory in Philadelphia. The people of the little Republic were urgently solicited to send them ores, etc., with the promises that the analyses would be made without charge and judgment given as to the value of the submitted material.

Could anything more patriotic be offered? American chemists should insist upon the world's recognition of this earliest chemical society—the first ever founded. Naturally, when the year 1792 is mentioned one is apt to turn away and in a deprecatory mood declare that our country, still in its swaddling clothes, was too young to possess a real society devoted to chemistry. In fact, the engrossing thoughts were as to *its* existence and *its* relation in the future to England and France. True, but nevertheless there was a group of men who carried forward the objects of the Chemical Society through a period of at least seventeen years. Some of its publications are still extant. They show the nature of its work, and the successors of that early group of American chemists, ought to be familiar with their contributions. Such knowledge would develop pride and respect for the fathers of the science.

In this pioneer work, Woodhouse was a potent factor. But probably his most wonderful contribution was made after Priestley came to America in 1794. In 1795, Wood-

house came into possession of his own laboratory. It is recorded that it was most modern for its day. In it worthwhile things were done. Priestley often visited it and pronounced it splendid in every particular. In it he observed Woodhouse at work—intent upon wiping out forever the phlogiston theory. On that problem Woodhouse had expended much thought and labour. In his laboratory he decomposed water and synthesized it, and also did many other fundamental things.

American chemists founded the first chemical society in the world, and they were potent factors in the final overthrow of the doctrine of phlogiston. Do our own modern texts mention these facts? Do any texts—American or foreign tell us about them? No, they are silent; silent because the successors of Woodhouse were ignorant or, or indifferent to, what he did. It must be remembered that at the time of that controversy, there was also a terrific turmoil taking place in politics. The old city of Philadelphia was rent and torn by conflicting views. There were threats of war with England and with France. The community in which Woodhouse quietly worked over his problems was not interested in his results, and the circle to which those results appealed was small, so that the kuowledge of what Woodhouse had accomplished was not spread abroad. Foreign countries were not concerned with anything scientific from this side of the water at that particular moment. To-day, however, when more than a century has passed it is proper for those who develop the history of the science before students to incorporate in their lectures this information. It is due, not only to these early investigators, but also to our country.

The laboratory of Woodhouse was the center for the scientists who congregated in those early days, not only for those who lived in Philadelphia, but those who came from other parts of the Union.

The writer has two bound volumes of manuscript lectures on chemistry by Woodhouse. Time and again he had read them. These lectures, viewed to-day so long after their delivery, are unique. They must have been exceedingly complete and they are suggestive of a real live mind back of them. It may be inferred that Woodhouse was a progressive in our science—that there was not anything in the literature which came to him which he did not familiarise himself and apply such portions as he considered worth applying.

Here is another interesting historical fact which emanated from Woodhouse. Until very recently no American chemist has discovered an element. Those who in any portion of the world, have been thus fortunate have been held in high esteem by their confréres everywhere. It was in the year 1807 that Sir Humphrey Davy electrolysed molten potash and molten caustic soda, liberating for the first time their basal principles—the elements potassium and sodium. In the following year, Gay-Lussac and Thenard, by a wholly different process isolated potassium. But in the interval of time between Sir Humphry Davy's work and that of Gay-Lussac and Thenard, James Woodhouse heated wood ashes intimately mixed lamp black in an iron crucible, and separated therefrom shing particles, which in contact with water created a turbulent reaction with the liberation of hydrogen gas. He was confident that he had the basal principle of the wood ashes. Other work and other duties seem to have intervened, so that the experiment, althought repeated by him and by others with similar results, was lost. Yet, there are old papers of that period in which this isolation of potassium is set forth. The "Elements of the Philosophy of Chemistry" by James Cutbush, printed in the year 1813, made a very clear and proper statement of the discovery, but who of us—what American chemist, until recently—ever knew that such an investigation had been carried on by Woodhouse. Its importance is now recogniesed. It was an original idea. It could not have been prompted by what Davy did, nor was there any likelihood that the work of Gay-Lussac in any manner influenced Woodhouse, who antedated the French chemists. Again, no mention of this disovery occurs in the volumes generarlly consulted when desirious of reading up the history of any metal. Americans have been ignorant of this fact—too long ignorant—and it is not asking too much to request those who issue publications in the future to include that part of the story written by Woodhouse, but unknown to the majority of writers on chemistry, when telling the story of the isolation of patassium.

The manner in which Woodhouse presented this discovery in his original lectures is simple and modest in the extreme.

He does not glory over his achievement but gives it as an accomplished fact without mentioning himself as in any way connected with it.

Woodhouse had never been taught directly by any European master. His inspiration had come from Benjamin Rush, and it was undoubtedly accentuated by his subsequent relations with Joseph Priestley, as well as by the discussions which were held in the Chemical Society of Philadelphia.

One can scarcely imagine the joy that those who take an interest in the early history of chemistry in htis country would *experience if by some turn of fortune's* wheel they might come into possession of the minutes of that early scientific body. The addresses made before it admirably exhibit what must have been the spirit of the members of the society. If we could have the actual minutes of the discussions which occurred, it would be still better.

A this time, another gifted pupil of Benjamin Rush was active in the chemical *field. He had absolutely abandoned* his medical career. This was Adam Seybert. Woodhouse and he were of the same age. They were probably rivals, and at times pretty active opponents. Both were unquestionably highly gifted. Seybert had done a lot of pioneer work in the analysis of air. He promptly adopted the antiphlogistic doctrine. He was one with Woodhouse in what he had acomplished in that particular direction, and was an open admirer of Woodhouse's work on the isolation of potassium.

It chanced that Woodhouse in his enthusiasm turned for a while to the mineral field, devoting himself to the analysis of minerals attracting considerable attention because of their value in a metallurgical way. Seybert was also keen in this direction and was undoubtedly a superior mineralogist. He had enjoyed study abroad, *in* France and in Germany, and was probably the first American who ever studied mineralogy in a German university, so that in this field at times, these two pioneers clashed. They had engaged in a rather heated discussion on the value of zinc blende, as it occurred at Phœnixville, Pa. Further, as to the value of the zinc which might be obtained from the ore, Woodhouse inclining to the view that it would probably not, in the long run, be a real source of good to the country; whereas, Seybert showed by experiment how readily the metal might be obtained and indicated uses for it. Time demonstrated that he was right. It is a pleasure to read their controversial essays. But Seybert became so involved in politics that he ceased to be a productive factor among our earliest chemists, although he ever retained an *interest in the science.*

It is true, as we now read the annals of Philadelphia society of all ranks in the last decade of the 18th century and the first decade of the 19th century, that the impression comes that religion had little *consideration.* Men were too much occupied with other things, chiefly, in founding the *government; and the citizenry* about them was wide awake to governmental matters. The line of demarcation between the Federalists and the Republicans (who later became the Democrate) was sharply drawn. At every table discussion were upon national matters, and it happened that Woodhouse was a very strong supporter of France. He adopted the French style of dress. He was somewhat indulgent and convivial—all of which was too much for Benjamin Silliman, who had come from a rather austere New England atmosphere. Yet, when one brushes aside his caustic *criticism of his* master, it is quite evident that for his scientific ability he entertained the deepest respect.

As early as 1798 Woodhouse prepared a little "Laboratory Guide of Chemical Experiments." Many of us have thought that the laboratory guide which we prepared for the use of our students represented a new era in the teaching of our science, and yet any person who examines the little Guide printed 129 years ago by James Woodhouse will acknowledge that our idea was his, and that we had better content ourselves by saying that his idea became ours.

Why should not the history of chemistry in America find its *place in the chemical* curriculum, which is laid before the students of chemistry now going through colleges and universities? There is no grander field for research! There is ample room for all who have the slightest inclination to turn their attention and thought that way. A great satisfaction will come to those who undertake this work. *It will bring them in* contact, so to speak, with the men themselves. They will learn to know them, not only through their work, through their books, but intimately through their letters. The latter throw sidelights upon the development of our science as nothin[illegible]

EDUCATION IN RELATION TO INDUSTRIAL ADMINISTRATIONS.

(*Continued from Page* 105.)

Suggested Field for Studies in Industrial and Commercial Administration.

It is felt desirable to emphasise the importance of a general economic knowledge in all students undertaking courses in administration. In those cases where students have not done such a course it is essential that some time be given to the fundamental principles of economics, quite apart from their particular application in individual sections of the adminstrative course. For ease of reference the following suggestions have been divided under three main headings :—

(*a*) Finance;
(*b*) Production;
(*c*) Distribution.

Each of these subjects has over-riding legal limitations which should be dealt with specifically in the sections.

Finance.

These lectures should cover the provision of capital for setting up a manufacturng or distributing enterprise, and also for the financing of the working of such enterprises. As such the various forms of business, *i.e.*, a private company, a private limited company, a limited company, amalgamations and associations including corporations and holding companies, public utility undertakings and voluntary associations, need consideration. This would also cover various types of capital. Working Capital would necessitate consideration of Banking methods, loans, discounts and credits. Exchanges, speculation and investments including commodities as well as stock script are also subject matter which are necessary for an appreciation of movements of currencies as reflected by foreign exchange. Normal Accountancy, that is, trading accounts including balance sheets would also be dealt with in this section. Taxation and Rating. Insurances, contributory schemes, etc., Bankruptcy.

Production.

Lay-out of works with special reference to routing. Stores and store organisaton including stocktaking. Power Provision and application especially as a cost factor. Machine standards. Costing and Rate fixing. Labour (*a*) selection and training, (*b*) methods of payment, individual agreements, collective bargaining. Trades Unions and Employers' Federations, (*c*) welfare and social aspects. Governments regulations—The Factory Acts. Public Health Acts and Industrial manufacture. Nuisances including smoke and liquid effluents. Patents and other forms of monopoly. Standardisation and Simplification Research.

Distribution.

Advertisement and publicity, Press advertising, Exhibitions, Catalogues, Posters, Trade Marks, Business Correspondence, Cinema and Wireless.

Marketing. Trade Channels, wholesale and retail. Commission Merchants, brokers and exporting houses. Brands, Trade Marks, Transport, Road, Railway, Shipping and Air, Transport documents, Insurances and Risks.

Selling. The personal factor, knowledge of commodities, languages and general commercial practices in particular countries.

Trade Agreements.

Sales Service as an intelligence service.

Statistics.

Trade statistics including production, consumption and marketing movements. Interpretation of statistics. The use of statistics in determining manufacturing policy.

GENERAL NOTES.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Applications for Licences in July, 1928.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 703, of which 575 were from merchants or importers. To these should be added 18 cases outstanding on the 30th June, making a total for the month of 721. These were dealt with as follows :—

Granted—656 (of which 628 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—53 (of which 45 were dealt with within 7 days of receipt).

Outstanding on 31st July—12.

Of the total of 721 applications received, 673, or 93 per cent., were dealt with within 7 days of receipt.

DEPARTMENT OF OVERSEAS TRADE.

NEW COMPTROLLER-GENERALH APPOINTMENT OF SIR EDWARD T. F. CROWE, C.M.G.

The Department of Overseas Trade announces that, with the approval of the Prime Minister, the Secretary of State for Foreign Affairs and the President of the Board of Trade have appointed Sir Edward Crowe, C.M.G., to fill the post of Comptroller-General vacated by Sir William H. Clark, K.C.S.I., C.M.G., on his appointment as High Commissioner in Canada for His Majesty's Government in Great Britain. Sir Edward Crowe took up his duties on 1 August.

STANDARD ROAD AND TRAFFIC SIGNS.

At a conference held recently at the Institution of Mechanical Engineers, called by the British Engineering Standards Association at the request of the Association of Public Lighting Engineers, the question of standardisation of the signs and signals for erection on roads was considered. While the conference did not feel that the time was yet ripe to recommend the setting up of a Committee for this purpose, the British Engineering Standards Association was asked to call them together again in about six months' time to consider the matter further.

WHOLESALE PRICES IN JULY.

BOARD OF TRADE INDEX NUMBER.

As measured at the Board of Trade, wholesale prices in July were on the average lower than in June by 1.1 per cent., the index numbers for the two months being 84.9 and 85.8 respectively (1924 = 100). The index for food shows a fall in July of 3.0 per cent. compared with June, while the aggregate figures for industrial materials are the same for the two months. Quotations for cereals were reduced on the average by 2.5 per cent., those for meat and fish by 4.5 per cent., and those for miscellaneous foods by 2.0 per cent. In the indices for the five groups of i ndustrial materials the largest movement is shown in metals and minerals, other than iron and steel, the July figure being 1.2 per cent. lower than that for June, the fall of 2 per cent. in the average of coal prices practically accounting for the decrease. The fall took place in house coal qualities. Iron and steel prices fell by an average of 0.8 per cent.

MOLYBDENUM, ANTIMONY AND TUNGSTEN MINES IN CANADA.

The Mines Branch of the Dominion Department of Mines at Ottawa has just issued a Revised Edition of List No. 2-6, "Molybdenum, Antimony and Tungsten Mines in Canada," showing companies operating in the various mining districts of Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, British Columbia and the Yukon Territory.

Copies of the list in question can be obtained shortly on application either to the Department of Mines at Ottawa, or to the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

NEW DIRECTOR OF FOREIGN DIVISION.

APPOINTMENT OF MR. J. PICTON BAGGE.

Mr. J. Picton Bagge, Commercial Secretary (First Grade) at Brussels, has been appointed Director of the Foreign Division of the Department of Overseas Trade in succession to Sir Edward Crowe, C.M.G., and he also took up his duties on 1 August.

Mr. Bagge joined the Consular Service in 1905 and served at various posts in Europe. He was promoted to the rank of Commercial Secretary (First Grade) in 1918, and after a period of duty in the Department of Overseas Trade proceeded to Berne in February, 1921, and was transferred to Brussels in November, 1922.

UNIVERSITY OF LONDON. UNIVERSITY COLLEGE.

DEPARTMENT OF CHEMICAL ENGINEERING.

Mr. J. P. Mullen, M.Eng. has been appointed Lecturer in the Department of Chemical Engineering, under the direction of Professor W. E. Gibbs, D.Sc. Mr. Mullen was educated at St. Edward School, Liverpool, and the University of Liverpool. He was Combustion and Production Engineer in the rolling mills and foundries of the Royal Ordnance Factories, Woolwich, and Ballistic Officer, H.M.S. "Excellent," Portsmouth, during the war. Since then he has undertaken research on refrigeration at the University of Illinois, has held the post of Development Engineer of the Western Electric Company, Chicago, and the post of Fuel Engineer, Anglo-Persion Oil Company.

TELEPHONES IN SWEDEN.

The following information regarding telephones in Sweden, extracted from the Statistical Report of the Swedish Telegraph Department for 1927, just published, has been received from the British Commercial Secretary at Stockholm :—

In 1927 the number of telephone stations was 4,735, of which 28 were private. Two automatic telephone exchanges are being built in Stockholm and one in Gotherburg.

Telephone conversations numbered 694.6 millions in 1927 as against 662.1 millions in 1926; of these 317,000 were to foreign countries against 308,000 in the preceding year; 298,000 from foreign countries against 276,000 and 60,000 through Sweden against 56,000 in 1926.

Of 615,000 telephone conversations with foreign countries Denmark accounted for 260,500; Norway for 197,500; Germany for 126,000; and Great Britain for 3,200 (first year of traffic). Telephone traffic was opened up during the year with Great Britain, France, Belgium, and the Netherlands.

The number of telephones, including extensions, in use in 1927 was 453,513 (or 74.5 per thousand inhabitants) as against 438,059 in 1926. The income derived from telephone traffic in 1927 amounted to 75,003,000 kr., as against 72,335,000 kr. in 1926. The length of telephone lines was 828,100 kilometres in 1927 as against 798,981 kilometres in the previous year.

CUBAN PARLIAMENT HOUSE FURNISHED BY BRITISH FIRM.

An interesting story was told by Lord Waring at the recent meeting of Waring and Gillow, Ltd. The Cuban Government, having built a new Parliament House desired to have it fitted and furnished in a sumptuous manner. Tenders were invited, but owing to some changes in the architect's plans, the forms were not received in England until too late to get the tenders to Cuba in time. Hundreds of pounds were spent in cables to secure a slight extension and then the Waring studio worked night and day on the 180 large designs required. These were sent by boat, train and aeroplane, reaching their destination with only twenty minutes to spare. In spite of competition from all parts of the world, the contract, amounting to about half a million pounds sterling was secured for this country. It is a wonderful tribute to English methods and superiority, and is a striking instance of what can be done by individual effort in bringing capital and employment into this country at a time when it needs it so much.

But Lord Waring is much more than a Captain of Industry with developing factories and great distributing depots, and with ramifications extending to every part of the world.

What the great leaders in Science, Law, Music and other professions have accomplished in their respective spheres Lord Waring has achieved in establishing a new standard of artistics taste and utility in home furnishing and decoration. The Brothers Adam, Sheraton, Chippendale and other great furniture artists and designers of the past made their impress on style but their work was mainly confined to the homes of the wealthy. Lord Waring is a worthy successor to them in the creation of a twentieth century conception of the ideal as illustrated in the furnishing of mansions, ocean liners, theatres and great public institutions at home and abroad. But he will best be remembered by posterity as the man who, of all others, has contributed most to the revolutionary change in the furnishing and decoration of the homes of the people, from that prevailing in the Victorian era. The home of the middle class in England to-day is the admiration of the world. It is characterised by an individuality in taste that compares favourably either with the mass production making for a monotonous uniformity or the ornate designs that destroy utility and are beyond the reach of the masses.

A rare combination of business genius and enterprise with an idealist conception of utilitarian art, Lord Waring's name will be recognised by future generations as one of the outstanding figures of his age.

BOARD OF TRADE ANNOUNCEMENT.

MERCHANDISE MARKS ACT, 1926.

COMMITTEE'S REPORT ON SURGICAL INSTRUMENTS AND APPLIANCES.

The Standing Committee (General Merchandise) appointed by the Board of Trade have reported on their enquiry as to whether imported surgical, medical, dental and veterinary instruments and appliances, and dental supplies and furniture should be required to bear an indication of origin.

The Report is obtainable from the Stationery Office, or through any Bookseller, price 2d. a copy.

AN INTERIM REPORT TO THE SHAREHOLDERS OF—MOTOR FUEL PROPRIETARY LTD.

The directors have considerable pleasure in announcing the results of some recent tests made at their commercial production plant at Slough before well-known experts.

A plant is capable of treating ten tons of coal a day and has borne out the claims which the company has made in connection with their Low Temperature Distillation Patent.

In brief, these results have proved conclusively that this process is not only a highly satisfactory one from the point of crude oil obtained from coal but that it can be operated on a very economic basis. The capital cost of plant, due to the simplicity of the process, is low as are the production costs. The two analyses (*a*) from Nottingham coal and (*b*) from Cannel coal, show how satisfactory in quantity is the resultant crude oil. Further refining yields petrol, lubricating, lamp and other oils in excellent grades and quantities. Still another feature is the smokeless fuel residue which should prove a big demand not only in the domestic market and for ordinary industrial purposes but also as pulverised fuel in marine and other boilers.

(a) From coal produced in Nottinghamshire :—

COAL TREATED : 17 TONS 14 CWTS.

	tons	cwts.	qrs.	lbs.	%
Crude oil		16	3	27	11.0
Residue	5	6	0	0	68.8
Water	1	9	0	26	19.0
Gas and loss ...		1	3	3	1.2
	7	14	0	0	100.0

Crude oil produced—230 gallons, or 30 gallons per ton.

(b) From Lancashire Cannel coal sent for treatment :—

COAL TREATED : 8 TONS 17 CWTS.

	tons	cwts.	qrs.	lbs.	%
Crude oil	2	15	0	10	31.1
Residue	4	12	0	24	52.1
Water		10	0	0	5.6
Gas and loss ...		19	2	22	11.2
	8	17	0	0	100.0

Crude oil produced—720 gallons or 81 gallons per ton.

The Directors are now, therefore, convinced that the time has come when Distillation of oil from coal at low temperature following this process can be operated commercially. They have, therefore, acquired an important site in the Nottingham coalfield for the erection of plant and oil refinery. Orders have already been placed with Messrs. Ruston and Hornsby, of Lincoln for the first retort of the new unit of 80 retorts. Negotiations have also taken place with a view to certain leading coalowners joining the Board.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY OF ARTS.

Abstract of paper read 2 April, 1928.

Standardisation in Apparatus for Science Teaching. By WILLIAM TAYLOR.

The object of this lecture is to call attention to the advantages of applying standardisation to apparatus for teaching science, to define some of the things to be attained and some to be avoided in standardisation, and to illustrate these points by showing apparatus comprising a limited number of very simple standardised optical and mechanical elements with which a large number of optical instruments may be built up.

The advantages of standardisation lie in the economy and convenience of uniform and simplified practice. In order to display the advantages of standardisation generally, let us consider the familiar case of writing papers. Long usage has established in business offices a notepaper measuring 10 inches by 8 inches. The economy of using this one standard lies in the fact that the paper can be made in indefinite quantities with the practical certainty of a ready market, and can therefore be sold at a lower price and is more readily available than if it were made in a variety of sizes. The convenience of having one standard size lies in the fact that all of the many appliances for typewriting, copying, dublicating, and storing, and the envelopes for posting, are also standardised to suit the paper, and these again are more readily available and less expensive than they would otherwise be.

But a paper of this size is too large for many other purposes, and accordingly, nearly forty years ago, I standardised smaller papers for use in our business at Leicester, by continuous halving of the 10 × 8 notepaper; and so we have bound blocks of papers and a multiplicity of business forms of the sizes shown here, namely, 8 × 5, 5 × 4, 4 × 2½ inches, and these

smaller sizes, as you can see, are obtained by continuous halving of the 10 × 8 paper without any waste.

But as yet nobody, I believe, manufactures blocks of paper in these standard sizes; at any rate, we have to get them made specially for us. Apparently the paper trade has not sufficient vision of the advantages of extending standardisation to smaller business papers in this way. It is prepared to supply paper cut to any size whatever, and the customers pay for the waste.

Somewhat outside the sphere of business papers there are Brief, Foolscap, and small notepapers, and others, which are more or less standardised, but these are not related by any system such as that of halving, and to that extent are lacking in economy and convenience.

For some years Mr. Hoover, in the United States Department of Commerce, has been actively promoting what he terms "simplified practice," which is sane standardisation, in the leading industries of that country. His work has effected a large economic saving and is contributing to the present prosperity of America.

The President of our Board of Trade is promoting a similar movement in this country, and all those manufacturers who, to serve the Great War, turned their factories from producing a variety of things, each in relatively small quantities, to the production of a few of those products in large quantities, and who found that their costs were reduced in many cases by as much as half, will recognise that simplification of practice is an important means of attaining low cost of production while maintaining high rates of wages; two things which are vitally necessary for this country at the present time.

The promotion of simplified practice through standardisation is, properly considered, a branch of Applied Science, and it is appropriate that it should be studied by teachers of Science and applied to meet their difficulty of procuring, with a minimum of expense and delay, apparatus for the teaching of Science.

In setting up simplified standards of practice, it must be borne in mind that, as the psychologists tell us, one of the most difficult things in the world is to change people's habits; and this is particularly difficult in old countries like our own. It is over a hundred years since France, as part of her great Revolution, started to establish by law the metric system of weights and measures; but that system has not, even yet, displaced all the old standards of measurement in use in France among the common people.

Because of the difficulty of uprooting old standards, it is frequently prudent, and therefore scientific, to preserve the old ones in spite of their not being ideally perfect. For example, it would be foolish to attempt to-day to upset the practice of using 10 × 8 inch notepaper in business unless we could provide paper of some other size, at far less cost, or otherwise much more attractive. And yet, from one point of view, 10 × 8 is not an ideal ratio of length to width, because when you cut 10 × 8 into two and get 8 × 5 the ratio is changed. The only basis on which we could maintain a constant proportion under these circumstances is to make the ratio $\frac{\sqrt{2}}{1}$ or approximately $\frac{14}{10}$. That is an ideal proportion which might perhaps be applied in the window glass trade, where, I believe, no very definite standards are yet adopted, and where there is enormous waste in cutting.

When standards are required for the dimensions of a series of articles of like kind, but differing in size, the number of standards should be a minimum. In every such case the advantages of standardisation are inversely as the number of standards. *Over-standardisation is mere systemisation,* and may be worse than no standardisation at all.

In order that the number of standards in any series shall be a minimum, it is generally desirable to arrange them in approximately geometrical progression and not in arithmetical progression. Here are two series of papers illustrating respectively arithmetical and geometrical progression. In the arithmetical series the papers increase successively in size by one-half inch each way. In the geometrical series, the first increase of area is equal to one-half inch each way, but it is made by doubling the area of the paper, and this system of doubling is applied successively right through the series. On looking at the arithmetical series, you will observe that while the difference of area between the two smallest members is substantial, that between the two largest is insignificant from any practical point of view. In the arithmetical series are 25 members. In the geometrical series, covering the same range, there are only 8 members. Whether it is for paper, or panes of glass, butter or rice, or shafts or

bolts for machinery, or lenses or other elements of scientific apparatus, the need for geometrical series holds true, and for this reason it is a great virtue of our sometimes despised systems of weights and measures, that they provide what we need for so many of the practical affairs of life, *viz.*, various geometrical units which we cannot find under a decimal system. This is the virtue for example, of our 16 ounces to the pound and of our division of the inch into halves, quarters, eighths, sixteenths, and so on. That geometrical progression is a virtue is the common experience of all people everywhere, for even in those countries where decimal systems of weights and measures prevail, the people still resort, with some difficulty, to dividing things into halves and quarters and eighths.

REDUCTION POTENTIAL OF NICOTINIC ACID.

By Masuzo Shikata and Isamu Tachi.
(College of Agriculture, Kyoto Imperial University.)

Introduction.

In the preceding paper, the electrolytic reduction of pyridine has been treated. In the present paper the reduction of the nicotinic acid was studied, in order to see the behaviour of such a compound, containing two reducible groups such as a pyridine ring and a carboxyl group.

The review of the literatures told us there seemed to have been found no attempt on the subject of the electrolytic reductions of nicotinic acid or on an exact measurement of its reduction potential.

In the present paper the result of the measurements of an electrolytic reduction potential of nicotinic acid in various solutions with the polarographic method, the consideration on the two reduction waves and the comparison of its reduction potential to that of benzoic acid will chiefly be described.

Experimental.

The method of procedure, the sensitivity of the galvanometer, and the determination of R. P. are quite in a similar way as given in Parts II and III. The niconinic acid is E. Merk's preparation, and its melting point is 230° C. (uncor.).

The measurement has been carried out in acidic, as well as in neutral salt solutions and in alkaline solutions at the temperature 15 ± 0.5° C. In the following tables, the results of the experiments are tabulated.

In the following tables the concentration of hydrogen ion [H$^{\cdot}$] were the values, which were obtained by the potentiometric measurements with a gas electrode or a quinhydrone electrode.

Summary of the Result.

1. The reduction potential of nicotinic acid was measured with the dropping mercury cathode and the polarograph.

2. Two stages of the reduction process were observed.

3. For the first stage of reduction, observed R. P. was compared with the theoretical value calculated by the following formula at 15° C.

$$\pi = -\frac{0.05713}{2}\log\frac{k'}{[H^{\cdot}]^2 C_{C_5H_4N.COOH}}$$

in which by taking the R. P. of 0.01 mol nicotinic acid in (0.01n HCl + 0.1n KCl) solution, i.e., − 0.984 V as a standard, we have

$$\log k' = 28.33$$

In an acidic as well as in a neutral salt salt solution, the observed R. P. showed satisfactory concordance with the calculated values, and thus the first stage has been concluded to be the reduction of carboxyl group of nicotinic acid to aldehyde.

4. The second stage of reduction is considered to be the reduction of pyridine ring of nicotinic acid, by comparison with the R. P. of pyridine in our preceding paper.

5. The reduction of nicotinic acid in an excess of alkali does not take place owing, perhaps, to the desorption of negatively changed nicotinic acid ions to the polarised mercury cathode. R. P. in a sodium acetate or sodium bicarbonate solution was about 0.02 V more negative than the calculated value.

6. Maximum of current voltage curve was observed in sodium bicarbonate solution, in which the potential of maximum current intensity was almost independent of the concentration of nicotinic acid.

7. The reduction potential of benzoic acid was studied for the sake of comparison, with the result that in hydrochloric acid, no reduction but only the deposition of hydrogen ion has been seen, while in potassium chloride solution the R.P. is over 0.240 V than that of the nicotinic acid. Thus the group effect of a carboxyl group is considered to be more effective than a benzene ring.

8. The decisive conclusion as to the reduction process has been left out for the time, when the isolation of the reduction product, now under investigation, would be completed.

NOTICES OF BOOKS.

A Text Book of Inorganic Chemistry. Edited by J. Newton Friend, D.Sc., Ph.D., F.I.C., Carnegie Gold Medallsit. Vol. VI. Part I. *Nitrogen.* By EDMUND D. B. PRIDEAUX, M.A., B.Sc., D.Sc., F.I.C., AND HERBERT LAMBOURNE, M.A., M.Sc., F.I.C. Pp. XVI + 242. Price 18s. net. London: Charles Griffin and Company, Ltd.

The present work is one of an excellent series of books dealing with inorganic chemistry. The works are being issued under good auspices, the general editor Professor J. Newton Friend, being a sucessful and popular scientific writer.

Owing to the increasing importance of Nitrogen for agricultural and other purposes, and its manufacture on a large scale, the publication of an authentic work of this kind is opportune and welcome. The chapters are arranged to the best advantage, there is a good index, and the work is attracticely produced.

Mechanochemistry and the Collind Mill, including Practical Applications of Fine Depression. By PIERCE M. TRAVIS, President, Travis Colloid Research Co., Inc. Pp. 192. Price $4. New York: The Chemical Catalogue Company, Inc.

The author predicts that within a few years the colloid mill will be a necessary piece of equipment for a great number of industries, and hence he hopes that those who operate such mills will acquire sufficient theoretical knowledge to enable them to conduct their investigations along correct lines. That the work which he has written will help in this and other directions we have not the least doubt. With a humility which is by no means universal the readers in critically perusing the work, and pointing out any errors which they might discover, so that correction might be made when a second edition is produced.

Photochemical Processes. (American Chemical Society Monograph Series). By GEORGE B. KISTIAKOWSKY (Research Associate in Chemistry, Princeton University). Pp. 270. Price $5.50. Book Dept., The Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, New York, U.S.A.

The present volume covers a field that has so far not been adequately covered, and hence its opportuneness at a time when the spirit of inquiry is so universal and active. The author formulates the second law of photochemistry thus:—"The absorption of light is a quantum process involving one quantum per absorbing molecule (or atom). The photochemical yield is determined by the thermal reactions of the system produced by the light absorptions." He claims that the pages of his work shew that such generalisation is adequate to the facts now known.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

22,409.—Baumgarter, E. — Manufacture of chromic compounds. August 2nd.

22,297.—Geigy Akt.-Ges., J. R.—Manufacture of azo-dyestuff. August 1st.

22,654.—Graesser - Mousanto Chemical Works, Ltd., and Hudson, D. P.—Production of salts of aromatic hydroxyaldehydes. August 4th.

22,322.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of condensation products of naphthalene, etc. August 1st.

22,703.—Thomas, J.—Production of dyestuff intermediates. August 4th.

Specifications Published.

294,396.—I. G. Farbenindustrie Akt.-Ges. —Process for the manufacture and production of formates.

289,879.—Verein fur Chemische und Metallurgische Produktion. — Processes for the manufacture of sulphuric anhydride and sulphuric acid.

294,494.—I. G. Farbenindustrie Akt.-Ges. —Treatment of hydrocarbons with electric arcs.

294,680.—Meldrums, Ltd., and Marsden, F. —Apparatus for effecting intimate contact of gases and liquids.

276,659.—Petersen, H.—Manufacture of sulphuric acid.

282,001.—Newport Co.—Para'-amino-ortho-benzoyl-benzoic acid and a process of making the same.

284,702.—Schmid, Dr. A., and Meissner, J. —Process of and apparatus for uninterruptedly washing nitroglycerine, nitroglycol, and like esters.

Abstract Published.

291,849.—Chlorinated naphthalene. — British Dyestuffs Corporation, Ltd., Hexagon House, Payman, J. B., and Gibson, W., Crumpsall Vale Chemical Works, both in Blackley, *Manchester.*

Naphthalene is chlorinated by passing chlorine gas into molten naphthalene at ordinary pressure and between 130° and 160° C., in the presence of a small amount of an inorganic chlorine carrier such as ferric chloride. The chlorination may be carried out either in the presence or absence of light. When the desired amount of chlorine has been absorbed the product is distilled under reduced pressure. An example is given in which chlorine is added till an increase in weight corresponding to four atoms of chlorine is reached.

292,342.—Hydrogen-nitrogen mixtures.— Sacchi, M. Casale-., Villa Porticciuolo, Rapallo, near Genoa, Italy.

Catalytic processes.—Mixtures of nitrogen and hydrogen, for example for ammonia synthesis, are prepared by fractionating liquid air so as to yield pure nitrogen and slightly impure oxygen, using the oxygen for the preparation of hydrogen by incomplete combustion of hydrocarbons in the known manner, and adding the nitrogen to the hydrogen so produced. The oxygen fraction may contain 2-3 per cent. or more of nitrogen. It is used in presence of steam for the incomplete combustion of the hydrocarbons, the carbon monoxide is catalytically converted into dioxide if necessary with addition of more steam, water is removed by cooling, and carbon dioxide by any suitable means, leaving pure hydrogen. Specification 274,010 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

489,709.—Illustration of a bell initialled with J. B. & C., and the words CAVENDISH A for chemical substances prepared for use in medicine and pharmacy.—Savory & Moore (1928) Limited, 8, Welbeck Street,

EMULSAGAR.

491,894.—Chemical substances prepared for use in medicine and pharmacy.— Burgoyne, Burbidges and Co., Ltd., High Street South, East Ham, London, E.6. July 25th.

PURGALETTE.

489,473.—Chemical substances prepared for use in medicine and pharmacy.— May and Baker, Ltd., Garden Wharf, Church Road, Battersea, London, S.W.11. August 8th.

KAMBEROL.

491,370.—Chemical substances used for veterinary purposes.—R. C. Treatt & Co., Ltd., 11, Hart Street, Mark Lane, London, E.C.3. August 8th.

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METRICAL CHARACTERISTICS OF THE SOLAR SYSTEM — SOME FURTHER OBSERVATIONS.

By F. H. LORING.

In the last article on the above subject—this Journal, July 20, 1928, CXXXVII, 83-87—a small but perhaps important peculiarity appears in connection with the harmonic-mean values when taken as representing an at-one-time planet that 'exploded.' Doubt about the use of the word *explosion* was discussed in the same article, the word being left undefined except in a general way.

Now referring to Table II, p. 86, it will be seen that the calculated period in the case of the at-one-time planet, of B number 21, came out at 4.011 years. This value does not agree with the period obtained by taking the harmonic mean of the distances (a) of the extreme asteroids, Eros and [illegible]

using Kepler's *third law, viz.*: The squares of the respective periods ($t_1^2 : t_2^2$) are proportional to the cubes of the respective mean distances ($a_1^3 : a_2^3$) from the sun; that is to say, $t_1^2 : t_2^2 = a_1^3 : a_2^3$. In the case of Saturn and Uranus there is also a difference of the same nature.

It is to be noted that the extreme fragments in the rings of Saturn give a harmonic mean value that fits into the B-number scheme—see p. 84 of the last article mentioned above. It should be of interest to note an extension of this idea. According to Table I, p. 84, the missing satellite of Jupiter had a supposed B number of 119, which satellite may have exploded, as already suggested; and if, as a consequence, Callisto and the 6th, 7th, 8th, and 9th satellites were so produced, then, taking extreme values, 63.606 and 816.4, they should give a harmonic mean of 119. This comes out at 118.2, which is near enough. Applying this calculation to the more remote satellites of Saturn does not yield a corresponding result, but there may be an undiscovered satellite beyond Phœbe. It is true that 63.606 is already a part of a bracketted value, and this is a feature to be kept in mind. However this may be, these peculiarities may otherwise mean that no planet or satellite could have existed in the stable state as represented by the harmonic-mean number, for on applying Kepler's third law, as above shown, the harmonic mean disdances do not agree with those expected from the periods, particularly as indicated by Table II.

All cases are not tested in this way, but those which have been examined, as stated above, show differences. It is therefore concluded that some disturbing body or matter was present. A resisting medium might be considered.

The laws of Kepler are deducible from, or conform to, the law of gravity, as indicated by Newton. Then recapitulating, the period 4.011 and the astronomical distance 2.825 (H.M.) are in conflict by Kepler's third law; therefore, an unstable state existed which *resulted in the breaking up of the planetary* matter which originally tended to the ideal value *i.e.*, the planet may have been "spoiled in the making."

Referring to the evaluation of the sunspot periods from B numbers (*loc. cit.* pp. 86, 87) there is still a higher number than 88 possible, since 119 affords a higher value, but this would appear to be the limit as

scheme can be given a trial; but, of course, the irregularities in sun-spot periods have to be considered. It is customary to take averages—not of course referring to the means here given.

$$(3 + 7)/2 = 5$$
$$(9 + 13)/2 = 11$$
$$(21 + 45)/2 = 33$$
$$(119 + 0)/2 = 59.5$$

In order to fit in a long period of 59 years, touching the highest sun-spot values, the years have to be taken in the following somewhat irregular way: *1778.5—1887.5*; 1870.5—1930? (or thereabout).

The reader may refer to the following additional literature which comes to hand, but it does not represet a complete main list as probably some important contributions are omitted:— Russell, Dugan and Stewart's "Astronomy," vol. I, p. 205; F. J. M. Stratton's "Astronomical Physics," 1925, p. 53; "The Sun," 1912, by C. G. Abbot, chapter V. Here mention is made that the period of Jupiter (11.86) is near to the pronounced sun-spot period averaging about 11 years, suggesting an *external* influence. See p. 37, *loc. cit.*

The reader might find it of interest to consult the following:— Asteroids, K. Hirayama, *Jap. Journ. Astron & Geophys.*, vol. V, No. 3. Magnetism based upon the structure of the atom, K. Honda, *Proc. Imp. Acad. of Japan*, Jan., 1928, vol IV, No. 1, p. 12; *Zeits. f. Phys.*, 1928, XLVII, pp. 691-701; W. S. Adams' address on the occasion of receiving the Bruce Medal. This relates to the "Past Twenty Years of Physical Astronomy," which is reprinted in *Science*, June 29, 1928, vol. LXVII, pp. 637-344. Also of interest is Sir J. H. Jeans' "Astronomy and Cosmogony," just published, and reviewed in *The Times* (London), of July 2, 16, 30, 1928; also reviewed in *The Chemical News*, Aug. 17, 1928. In this book Jeans makes clear the origins of the conception of matter transforming into radiation, the first idea being traced to Newton. Jeans in 1904 (Nature, LXX, 101) suggested the complete annihilation of matter at the birth of radiation so to speak —positive and negative electrons rushing together and completely neutralising and annihilating one another. Perrin in 1919 *Ann. de Physique*, II, 89; *Revue du Mois*, 1920, XXI, 113) and Eddington in 1920 *British Association*, Cardiff, 1920, Sec. A) developed the idea further in connection with Einstein's theory of relativity (1905) and arrived at a result similar to that cited by the present writer in the article on Nova Pictoris (this Journal, CXXXVI, 276) which forms a part of this group of articles.

It is of great interest to observe in this connection that R. A. Millikan and G. H. Cameron now claim that the very-high-frequency cosmic-rays arise from the formation of helium, nitrogen, oxygen, magnesium, and silicon, out of hydrogen (protons), or out of helium in some cases: for their cosmic rays reveal *bands*, which from *Einstein's theory of relativity and the newer* mass values by Aston give the energies corresponding to the formation of the foregoing elements (not perhaps all because N and Mg are close to O and Si and it is difficult to separate them by the band method) and those so formed are the most widely disposed in the universe. Together with iron they would be the greatly predominating elements of the universe, at least as in the main spectroscopically revealed. Perhaps calcium and one or two other elements should be included here, but this is a matter for more detailed consideration. Nebulium of the nebulæ has turned out to be nitrogen and oxygen in highly ionised and metastable states from the recent work of I. S. Bowen (*Astrophys. Journ.*, 1928, LVII, 1). In this paper it is stated that "eight of the strongest nebular lines are classified as due to electron jumps from metastable states in N_{II}, O_{II}, O_{III}; and that several of the weaker lines are identified with recently discovered lines in the spectrum of highly ionised oxygen and nitrogen . . . A metastable state may be considered to be one from which jumps are very improbable." Millikan and Cameron say that the above evidence is both *qualitative* and *quantitative*. See *Phys. Rev.*, 1928, XXXI, 163; *Proc. Nat. Acad. Sci. U.S.A.*, 1928, XIV, 445. The following paragrapb from the latter paper is of interest in supplementing the above statement. "If the Einstein special theory of relativity may be taken as a sound basis of reasoning . . . then it follows that radiant energy can never escape from an atomic system without the disappearance of an equivalent amount of mass from that system, these relations being contained in the now well-known and universally used equation of Einstein (1905) $Mc^2 = E$, where M is mass in grams, c is the velocity of light in centimeters per second and E is energy in ergs. Now through the

recent, very exact work of Aston (*Proc. Roy. Soc.*, 1927, vol. 115, 487) we know the mass of every one of the atoms with a great deal of certainty, and we can therefore compute the amount of ether-wave energy that can be generated by any sort of atomic transformation that can take place, and knowing this energy we can compute with the aid of the Einstein equation the frequency, and with the aid of the Dirac formula (*Proc. Roy. Soc.*, 1925, vol. 109, 206) the penetrating powers of the rays resulting from all possible transformations. *Such studies reveal the fact that there are no possible transformations capable of yielding rays of the enormous penetrating powers observed by Millikan and Cameron except those corresponding to the building up or creation of the abundant elements like helium, oxygen, silicon and iron out of hydrogen, or in the case of the last two elements out of helium.* The entire annihilation of hydrogen by the falling completely together of its positive and negative electrons might be an additional possibility, but it can be eliminated in this case for two excellent reasons. [Here scientists agree in the main but differ in the particular, for Jeans has advanced the total annihilation theory as applied to stars and nebulæ.] The first of these reasons is that there is practically no place whatever for such a radiation to occupy in the observed ionisation-depth curve . . ., for it would be between four and five times more penetrating than the radiation that has the smallest absorption co-efficient mentioned above [see original]. The ionisation due to it, if it exists, would then have to be included in the 2.4 ions which represents the 'zero of the electroscope' as shown in the figure. But this 2.4 ions is only about one-tenth of the observed ionisation at the top of the curve, viz., 21 ions, this topmost reading corresponding to a depth of 1m. below the surface of Gem Lake. So that this hypothetical radiation can have nothing to do with the observed ionisation-depth curve much above the reading 2.4, and below it there is of course room only for a radiation relatively negligible in intensity in comparison with the softer rays that are responsible for the observed curve. The second reason is that this hypothetical radiation, if it were present, would of necessity be homogeneous, and could not therefore exhibit the banded structure shown by the observed cosmic rays. Whether then this act of the entire annihilation of the hydrogen atom through the coming into complete coincidence of the positive and negative electrons takes place or not, it can certainly be eliminated as a cause of the *observed* cosmic rays. There remains, then, no other atomic transformation . . . except the aforementioned *atom-building* processes. It is important to note that no step-by-step process of building up, or for that matter of disintegrating of atoms, in which one positive electron or one alpha particle is added or subtracted at a time will suffice for the generation of the cosmic rays, since the Einstein equation tells us that in no case can such a transformation produce rays of more than from one-fourth to one-twenty-fifth of the observed penetratig power. The observed extraordinary penetrating cosmic rays present, then, when taken in connection with Einstein's equation and Aston's findings not only the first direct evidence that the more abundant elements *are now in process* of being created out of positive and negative electrons, but they also present the first indications as to the general character of the specific act or acts by which the *atom-building* process goes on. So we have used only the general or qualitative evidence but it will be seen that from it alone the conclusion is scarcely escapable that the powerful cosmic rays here studied can be produced only by the creation *in a single act*, elements out of the primordial positive and negative electrons."—The italics are those of *M. & C.*

These matters are of such great importance that the reader will, it is hoped, pardon this expansion of the subject, especially since Jeans is following up a similar line of study as will be seen from the following.

Jeans shows that the stars are liquid in their central regions, a condition he finds necessary for stability, and that massive atoms of atomic number about 95 are concentrated in these regions, as such atoms would gravitate towards the star's centre. These massive atoms have been and are still in many cases (in all visible stars) the cause of protons and electrons falling together and completely neutralising each other, the result being a sort of super-radioactivity, which generates radiation of the X-ray type, whilst the masses of these two entities disappear, and this resulting high-frequency radiation is absorbed and transformed into temperature radiation in issuing from the star. Its passage through the star's interior causes in effect this change in wave-length. A time is reached, howeer, when the star's atoms become completely stripped of outer

electrons—*used up* in manufacturing radiation would perhaps express the idea here—and then it is that the super-radioactive atoms, so to speak, cease to function as sources of radiation according to this process.* Stars of this kind then become *white dwarfs* which are small and exceedingly dense having their atoms more closely packed owing to their reduced sizes, gravity still acting as a powerful consolidating agent. Stars thus lose mass by radiation (our sun is, on this view, losing mass at the prodigious rate of about 4 million tons a second. It is so massive, however, that this can go on for millions upon millions of years unless something happens to stop the process—to make the sun pass over into the dwarf stage), but the dwarfs having lost much mass and having practically ended their careers as luminaries are still objects of great interest, for their now-feeble radiation has in one definite instance revealed a spectral line displacement indicating enormous density in accordance with Einstein's prediction based upon his theory of relativity; or, strictly speaking, Eddington's prediction in applying this theory to white dwarfs. This is not the full story. The companion to Sirius (the companion a star of the dwarf type here described) behaved as if it were massive though small, and to account for its apparently abnormal pulling action on Sirius its mass had to be such as to make its extraodinarily dense. Supposing this to be the case, its spectral lines should be shifted toward the infra-red end of the spectrum according to Einstein's theory, and this was found by the brilliant work of Adams to be the case. All this is in agreement with Jeans' recent views, expounded so ably in his new book, which are only touched upon here.

* Jeans on p. 132 (" Astronomy and Cosmogony ") says : " We must suppose that one of the heavy atoms in a star's interior first begins to change into radiation through one of its bound electrons falling into the nucleus [of the atom], and coalescing with one of the nuclear protons so that both are annihilated. It is immaterial whether the whole atom changes into radiation at once or through a succession of comparatively slow changes. In either case the process of annihilation is likely *to consist of a series of events in each* of which a single proton and a single electron are annihilated simultaneously."

Some Minor Corrections.

These are mostly typographical error which the writer overlooked in the MSS. and proofs. The higher page-numbers refe to vol. CXXXVI, 1928, and the lower page numbers to the following vol. of the same year.

P. 225—Insert 1925 after " *Handbook* " in footnote.

276—Delete " full " in 1st line. Below table, " -1.27 " should read -1.33. 2nd col. 15th line up, " is " should read are.

277—17th line down, " the star " should read the new star. 1st col., 18th line up, " expanation " should read explanation.

35—1st col., 5th line down, " planets " should read satellites.

36—Under table " 8 per cent.," should read 7 per cent. 2nd col., 11th line up, Schostakowitch should read Schostakowitsch.

37—16th line down, " or " should read of.

THE ESTIMATION OF GOLD AND SILVER IN SEA WATER.

By Mataichi Yasuda.

(*Bulletin of the Chemical Society of Japan.*)

In regard to the estimations of gold and silver in sea water, the method of Sonstadt was published at the early time and at present this method is still used frequently. In recente tim H. Koch and F. Haber have published new methods. Of course, it seems to be very excellent. But I thought some skill is necessary to carry out their methods and to obtain some reliable results.

I tried to estimate the gold and the silver by an old method of Scheibler by notice of Dr. S. Iimori, and modified it by adding mercuric chloride solution and reduced them with metallic magnesium and concentrated hydrochloric acid. By this treatment the mercury deposits in fine metallic particles which catch all the gold and the silver as amalgams. It seems to be very excellent in the point that the metals obtained as heavy black precipitates.

Prof. Dr. P. P. Weimarn suggested that the gold in the sea water existed in the following states : (1 from colloidal to suspensoid, (2) metallic state in quartz and other earths, (3) gold in the organic colloids, (4) dissolved ionic states of trivalent as Au..., (5) the same of monovalent as Au'. H.

Koch thougbt, also, that the gold in sea water exists as ionic states, though it once changes to submicron particles by some organic reducing agents, it should be again converted into ionic state by oxidation. It is supposed that the cupric and the ferric ions existing in the sea water serve as the oxidising agent. My analytical method, however, can estimate all of the gold except that in the organic colloids. The details of the method are as follow :—

Two litres of sea water to be examined are taken into a separating funnel of 2.5 litres capacity, and 4-5 grams of powdered or shaved metallic magnesium added. The magnesium must, previously, be freed from any oily contaminations, by washing with ether two or three times, because the commercial magnesium is usually contaminated with machine oils, etc. Then add 20 c.c. of 0.05 mol per litre solution of mercuric chloride, and 40 or 50 c.c. of strong hydrochloric acid (38 per cent. HCl.). Now strong effervescence takes place with the evolution of the hydrogen gas, and deposits the white mercurous chloride at once. The deposition however, gradually changes to grey colour by the formation of the metallic mercury. The fine particles of the mercury settle down, catching all the gold and silver as amalgams.

After the reaction has finished, the heavy black precipitate is filtered. When emptied, the separating funnel is washed once more with water and alcohol to remove all the black matter.

The filter paper contains all the amalgam of the precious metals. It is dried and burnt, and the residue enclosed in pure lead sheet and put in a small crucible. Next heat the crucible with gas flame, adding two grams of gold- and silver-free lead oxide to oxidise the remaining carbon and to absorb the precious metals into the lead button. The button obtained in this way is cupelled on the bone ash in the muffle, and a small bead is obtained. The bead is weighed with a balance of 0.001mg. sensitivity, and then is taken into a small glass dish of 15 mm. diameter.

If the colour of the bead is white it is dissolved directly in a drop of nitric acid (specific gravity, 1.26). If the colour of the bead is yellow or yellowish-green, it is dissolved in a drop of mercury (free from gold and silver, of course), and then is dissolved in a drop of nitric acid. The gold remains in the form of black powder after such treatment. Next dip the small dish into a large white porcelain dish filled with distilled water, and move it by means of a small pincette coated with celluloid, to dissolve out the silver and the mercury nitrate, to and fro, up and down, in the water, until the black residue of gold is purified sufficiently. It happens frequently, during this treatment, that the black residue floats out from the small dish. In such a case the black residue is collected with a small dust-pan with a long handle made of white celluloid, and a small feather, and then transferred into the small dish.

By this method all the gold can be collected in the small dish, which is then evaporated to dryness, and heated to 250° C. After cooling in a desiccator, it is weighed. The heating should begin slowly, otherwise the gold residue sometimes springs out and is lost.

The blank tests of the method have been carried out on three per cent. solution of sodium chloride, in which the known quantities of gold chloride had been added.

REDUCTION POTENTIALS OF PYRIDINE.

By Masuzo Shikata and Isamu Tachi.

(College of Agriculture, Ryoto Imperial University).

Introduction.

In the previous papers we have dealt with the reduction of reversible process. In the present paper a reduction of an irreversible process will be treated.

The ordinary electrolytic reduction of pyridine has been described by F. Ahrens, Pincussohn, E. Merk, Tafel, Marie and Lejenne, and Emmert.

In most of these experiments, the reduction of pyridine in the form of sulphate, was carried out with lead cathode, resulting in the formation of piperidine.

It was reported by Ahrens, that the yield of piperidine is 95 per cent. of the theoretical value. According to Marie and Lejenne, the reduction product is 65 per cent. of the piperidine, with the oily compound of pyridinetetrahydride as a by-product.

E. v. Zappi has electrolytically reduced pyridine with mercury cathode in sulphuric acid solution, with a good yield of piperidine. But no exact measurement of R. P. of pyridine seems to have been reported.

Summary of the Results.

(1) Reduction potential of pyridine was measured with the dropping mercury cathode and the polarograph.

(2) In the reduction of pyridine the two waves in the current voltage curve were found, and it was proved that the first wave is due to the reduction of the pyridine ion, and the second wave is due to the reduction of the undissociated pyridine molecule.

(3) To examine the extent to which the theory of reversible reduction can be applied to such an irreversible reduction system as pyridine-piperidine system, we applied the theory of reversible reduction.

By assuming the following formula as applicable, we calculated a so-called "theoretical value" and compared it with the observed value.

$$\pi = -\frac{RT}{6F}\ln\frac{k'}{(H^{\cdot})^{6}(\text{Pyridine})}$$

for the R.P. of undissociated pyridine molecule, and

$$\pi = -\frac{RT}{6F}\ln\frac{k''}{(H.)(\text{Pyridine}+)}$$

for the R.P. of pyridine ion.

Calculating from the R.P.I. of $1.251.10^{-1}$ m in 0.1n HCl solution (R.P.1 = - 1.296 V)
log k″ = 102.606 for pyridine ion.
Calculating also from $1.251.10^{-1}$m pyridine in the mixture (0.001_n HCl + 0.1_n KCl) solution (R.P.II = - 1.590 V)
log k′ = 116.407 (for pyridine molecule).

By taking these values as standards, it was found that in an acidic solution, the R. P. shows a paralled relation with the theoretical value, although the deviation is much greater than that of the reversible reduction; but in a neutral and an alkaline solution, the relation is not so simple.

(4) To show the behaviour of pyridine at the electrode, the adsorption coefficient was introduced into the formula and calculation.

For relatively higb concentration of pyridine.
in acidic solutions m = 0.219 (for pyridine ion)
in neutral solutions m = 0.089 (for pyridine ion)
in alkaline solutions m = 0.223 (for undissociated pyridine molecule)

(5) The electrolytic reduction potential is recommended as the general expression for reduction potentials in reversible and irreversible reduction.

SCIENTIFIC FOUNDATIONS OF THE REFINING OF PETROLEUM.

By A. E. Dunstan, D.Sc. (London), F.I.C., F.C.S.

(Introducton to Cantor Lectures.)
Gas and Gasoline.

(Delivered before the Royal Society of Arts, January, 1928.)

(Continued from Page 116.)

Petroleum Production in 1886 and 1927.

1886—*Circa* 3,000,000 tons.
1927.—170,000,000 tons (estimated) mainly made up from—

	tons
United States	120,500,000
Russia	10,000,000
Venezuela	9,270,000
Mexico	9,250,000
Persia	5,140,000
Roumania	3,720,000

As is the case to-day so it was forty years ago, that America is the foremost producer of mineral oil. But whereas in 1886 the major need of the world was for lamp oil, to-day civilisation demands an extraordinary wide range of products, namely, a comprehensive range of motor fuels, extraction spirits, pait spirits, white spirits, kerosene for power, heating and lighting, gas oils for fuel and for carburetting water gas, lubricating oils of all degrees of viscosity, switch oils, transformed oils, vaselines, waxes and pitches.

Chemical and Physical Nature of Petroleum.

Mineral oil as it issues from the earth is a mixture of solids, liquids and gases, not only in true physical solution, but also existing in the colloidal state. The gas (natural gas) is in the main, methane, the first member of the paraffin series, but there are also present ethane, propane, and butane, together with relatively small amounts of hydrogen sulphide, oxygen, carbon, dioxide, nitrogen, and in some cases helium. According as its content of readily liquefiable hydrocarbon is great or small, so the gas is regarded as "wet" or "dry."

Typical analyses of dry or wet gases are shown in Table II.

Although in the earlier days of the industry natural gas was regarded merely as fuel, yet up to 1920, 1,000,000,000,000 c.ft. were wasted. At the present time it is made use

TABLE II.

	CH_4	C_2H_6	C_3H_8	C_4H_{10}	N_2	CO_2
Pittsburg (dry) gas sp.gr. 0.65	84.7	9.4	3.0	1.3	1.6	trace
Riverside, West Virginia (wet gas) sp.gr. 1.38	18.0			78.7	3.3	
Persian Gas after absorption sp.gr. 0.99 to 1.08	40	21	18	9	—	H_2S 12

of more and more as a source of gasoline. In 1927, 1,600,000,000 gallons of gasoline were extracted, *i.e.*, about 4 per cent of the crude oil produced.

The first four members of the paraffin series, methane, ethane and propane and butane are gases, but pentane and other higher members are present, and these are liquid under ordinary temperatures and pressures.

TABLE III. (Burrell).

	Boiling point °C.	Boiling temperature °C.	Critical pressure atmos.
Methane	-160	-81.8	54.9
Ethane	-93	35	45.2
Propane	-37	97	44
n butane	+1	153	36
n pentane	37	197	33
n hexane	71.5	234.8	30

GENERAL NOTES.

COAL PRODUCTION IN CANADA SHOWS LARGE GAIN.

According to the Dominion Bureau of Statistics, coal production in Canada during June was 1,338,461 long tons ,or 6.4 per cent. higher than in May and 33 per cent. greater than the average for the month in the five preceding years.

A new record production of 194,662 tons of coke during June is also reported. This not only exceeds the previous high record of 192,645 tons established in May, but is also 14 per cent. over the output of 168,514 tons made in June, 1927.

Production of coal for the first six months of 1928 was 8,218,547 tons, a slight decrease from the 8,424,631 tons produced in the first six months of 1927, but 20 per cent. in advance of the average for the period in the past five years. Coke production for the six-month period of 1928 at 1,095,191 tons shows a marked advance over the production for the same period in 1927, which was 998,046 tons.

ANTI-SMOKE WAR IN THE NORTH.

The Northern counties are showing an example to the rest of the country by their enterprise in dealing with the domestic smoke problem. Many local authorities are taking active steps to give effect to the spirit of the National Smoke Abatement Conference's recommendation that greater use should be made of existing powers in tackling the domestic smoke nuisance. Smokeless fuel derived from low temperature carbonisation for raw coal is being recommended. In new housing estates provision has been made either for the encouragement of the burning of smokeless fuel, as in the case of Hull, or for the installation on a scale hitherto unattempted of gas fires, cookers and water-heaters, or electrical appliances in districts where the price of electricity makes it an economic alternative.

PLAN TO EXPORT NATURAL GAS FROM ALBERTA TO UNITED STATES.

At the Annual Meeting of the Range Oil and Gas Company held at Calgary, Alberta, it was indicated that if the present plans of the Company are consummated, surplus natural gas from the Province of Alberta will be available in the neighbouring State of Montana by next winter.

The Company recently received a permit from the Federal Government to export natural gas to theUnited States from the Rogers-Imperial wel llocated 25 miles east of Coutts and 4 miles north of the International boundary. It is proposed to construct a pipeline this year to the U.S. boundary and into Montana either to connect with the present pipeline to the City of Great Falls or as a separate line to be supplied with gas from the Rogers-Imperial dome. The well, which has been capped since 1925, is one of the greatest natural gas wells in Canada. It is reported to have a rock pressure of 1,300 pounds to the square inch and a flow of probably 50,000,000 cubic feet of gas daily.

The Range Oil and Gas Company is also drilling a second well on the Rogers-Im-

perial structure, which comprises 18,000 acres. The derrick is up, the necessary machinery on the ground and spudding in has been done. It is expected that before winter the second well will be completed.

The grant of the Federal permit to export gas to the United States, it is understood, will mean the opening of big markets in the State of Montana. It is expected that the supply of gas to Great Falls will start on the initial basis of 10,000,000 feet daily.

PRODUCTION OF STEEL IN CANADA INCREASE BY ONE-THIRD.

According to a Report issued by the Dominion Bureau of Statistics, the production of pig iron in Canada for the first half of 1928 was 468,013 long tons, as compared with 403,712 tons in the corresponding period of 1927.

Cumulative production of steel ingots and castings during the first siv months of the present year totalled 648,338 tons, an increase of 33 per cent. over the 487,810 tons made in the corresponding period of 1927.

In June, production of pig iron totalled 97,379 tons, a gain of 11 per cent. over the 87,811 tons made in the previous month and 40 per cent. higher than the output of 69,437 tons proluced in June of last year. Tonnage of steel ingots and castings produced in June totalled 116,530 tons, or slightly less than the 117,655 tons produced in May, but 94 per cent. greater than the 59,940 tons made in June of 1927.

The number of furnaces in blast on June 30 remained the same as on May 31, and these were located as follows :— Sydney, N.S., 2; Hamiltan, Ont., 2; Sault Ste. Marie, Ont., 2; Port Colborne, Ont., 1.

LARGE ARMY OF PROSPECTORS IN NORTHERN CANADA.

According to a statement made by a correspondent of the *Regina Leader* who has been checking the number of people who have gone into the mning fields of Northern Manitoba and Saskatchewan this year, in the month of June three thousand people travelled on the new Flin Flon Railway to Granberry Portage, a distance of 50 miles. A thousand more went during March, April and May and during the first half of July. Since March 1, 1,500 persons were carried northward on first-class tickets on the Hudson Bay Railway and numerous others on behalf of the railways and construction companies. This does not include several hundred who passed through on transportation from the eact. Altogether, it is stated, about 6,000 persons have gone north in the last six weeks, presumably for the purpose of examining mineral areas and staking claims.

In addition to all the prospectors who have entered the north by way of The Pas, there are the prospecting expeditions of Northern Aerial Minerals Exploration, Ltd., and Dominion Explorers, Ltld., which have sailed from Saint John and Halifax for Hudson Bay.

" DUSTING " FORESTS BY AEROPLANE IN NORTHERN CANADA.

Aeroplanes, scientific workers and commercial organisations have combined their forces in an effort to find the best method to control the spruce bud worm in Canada. It is estimated that 200,000,000 cords of wood have been destroyed by this pest since 1909, which means a loss to the Dominion of $2,000,000,000.

The work being done is purely investigational, and consists in the dusting from the air with different strengths of calcium arsenate of twelve 10-acre plots of different types of timber.

The budworm principally affects the balsam, and the trees are dusted when the budworm is in the caterpillar stage. The caterpillar bores into the bud ind feeds on the new foliage.

The experiments are being conducted near Westree on the Canadian National Railway west of Sudbury, Ontario. A " Keystone Puffer " aeroplane is used for the dusting. It is of the same type as those used for the cotton dusting in the Southern States. The Dominion Air Service is supplying the 'plane; the Entomological Branch of the Dominion Department of Agriculture the scientific investigators; and the Ontario Forestry Branch and the Spanish River Pulp and Paper Company are lending their assistance and co-operation.

Last year some preliminary investigations were conducted, this year they are being continued in an effort to perfect this method of control. If the dusting method of control can be effectively employed it will mean a tremendous economic saving to Canada.

DEPARTMENT OF OVERSEAS TRADE.

His Majesty's Consul-General at Montevideo reports that tenders are invited by the State Electricity Supply Works at that city for the supply of the following among other materials :—

5,000	kilogs	linseed oil.
8,500	,,	mineral grease.
400	,,	muriatic acid.
1,600	,,	sulphuric acid.
12,000	,,	crystallised soda.
11,800	,,	paint, white, lead, etc.
15,000	,,	refractory earth.
13,440	sheets	emery cloth.
10,000	steel	clamps with winged nut.
150	kerosene	lamps for trenches.
2,500	litres	spirits of turpentine.

In most cases samples have to be submitted with the tenders.

Tenders in sealed envelopes will be received at the offices of the "Administración-General de las Usinas Eléctricas del Estado," Calle Mercedes 993, Montevideo, up to 4 p.m. on the 24 September next.

Local representation is essential. The Department of Overseas Trade will be pleased to supply British firms not already represented in Uruguay with the names of agents who may be willing to act for them.

Further particulars of this call for tenders may be obtained by United Kingdom firms on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., where a copy of the specifications and conditions of tender (in Spanish) may also be seen. A complete translation of the specification, etc., may be obtained from the Department at a cost of five shillings per copy.

SAFEGUARDING OF KEY INDUSTRIES.

Representations have been made to the Board of Trade under Section 10(5) of the Finance Act, 1926, regarding butyl chloral hydrate, celtium oxide, dysprosium oxide, erbium oxide, europium oxide, gadolinium oxide, holmium oxide, lutecium oxide, samarium oxide, terbium oxide, thulium oxide, and ytterbium oxide.

Section 10(5) of the Finance Act, 1926, is as follows :—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any communications with respect to these representations should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, London, S.W.1. within one month from the date of this notice.

ASBESTOS DEMAND AND RHODESIA.

It is estimated that peak production figures have been reached in the Canadian Asbestos mines. Vast deposits in South Africa may be looked to to supply the ever-increasing world demand. The Rhodesian output is constantly increasing, and the Rhodesian fibre is preferred by many manufacturers to any other, as its even grading and superior felting qualities make it possible to use cheaper grades for spinning than with the fibres of other countries. Plant is being installed in some cases to treat the rock on the spot, but generally hand working is still resorted to. *Rhodesia undoubtedly possesses the most extensive and richest asbestos field in the world* and with the enormously increased demand exploitation of the dormant deposits is being eagerly and profitably proceeded with. This prosperity is reflected in the market prices of shares of all asbestos companies operating in the area.

FIREDAMP IN MINES.

The practical method of testing for firedamp in coal mines by means of the "cap" it produces on the flame of a safety-lamp still holds the field for convenience and accuracy. Testing for gas, and estimation o fthe amount present, can be satisfactorily carried out with any well-designed flame safety-lamp, but lamps of different types introduced into an atmosphere containing a given amount of firedamp do not necessarily show the same height and character of cap. In consequence, a fireman accustomed to a particular type of lamp might be seriously at fault in his estimation of firedamp were he to test with another type.

A photographic method of reproducing flame-caps pictorially for the instruction of firemen and deputies has been developed and is described in a paper by C. S. W. Grice and D. W. Woodhead, entitled "The estimation of firedamp: flame caps" (Safety in Mines Research Board Paper No. 37, H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2., price 1s. net). The paper is accompanied by coloured reproductions of the caps shown by two very different types of lamps, both in wide use in the industry, in atmospheres containing various percentages of firedamp.

DEEDS OF ARRANGEMENT, RECEIVING AND ADMINISTRATION ORDERS, 1917 TO 1926.

Year	Number of Deeds	Receiving and Administration Orders
1917	612 ...	1,089
1918	198 ...	628
1919	165 ...	745
1920	451 ...	1,565
1921	1,368 ...	3,472
1922	1,847 ...	4,733
1923	1,808 ...	5,048
1924	1,901 ...	4,794
1925	1,877 ...	4,708
1926	1,763 ...	4,239
Decrease during 1926	114 ...	469

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

Thursday, June 28.

The Bakerian Lecture was delivered by PROF. J. C. McLENNAN, F.R.S., on *The Aurora and its Spectrum.*

The two outstanding features that characterise the spectrum of the polar aurora are a set of four well-marked bands belonging to the first negative group of nitrogen, and a strongly defined very narrow spectral line in the green, whose wave-length measured by Babcock with a Fabry and Perot interferometer was bound to be 5577.35 ± 0.005 A. Less important features are a set of bands belonging to the second positive group of nitrogen and a miscellaneous, and as yet unindentified, set of sixteen lines or narrow bands. The auroral green line, whose identity was for long unknown, was shown in 1925 by McLennan and Shrum to originate in gaseous atomic oxygen. This spectral line has been shown to exhibit great variations in intensity with changing conditions of excitation. Helium anw Neon when maxed in excess with oxygen enhance the intensity of the line. Argon does the same thing, but to a much greater extent. In 1927 McLennan and McLeod established the identity of the oxygen green line with the auroral green line beyond question, through obtaining 5577.341 A ± 0.004 A for the wave-length of the former by the use of a Fabry and Perot interferometer.

The region in which auroræ generally occur in the uppe ratmosphere has for its lower boundary a height of approximately 80 kms., and for its upper limit a height of more than 400 kms. Auroræ occur with greatest frequency and brilliance at a height of 98 kms., but they have been observed as high as 1,000kms. It follows, then, that oxygen and nitrogen must be constituents of the earth's atmosphere up to these great heights. Through the work of Campbell, Lord Rayleigh, Slipher and others it is now known that, on any clear night in any latitute, the whole sky is glowing with a faint green light, which is monochromatic and has the same wave-length as the "green line" of the polar aurora. While the polar aurora appears to be excited by streams of electrons emitted by the sun from time to time, the green light of the non-polar aurora appears to originate through the action of some other agent.

The presence of the first negative bands of nitrogen in the spectrum of the aurora connotes an "excitation potential" of 19.6 volts, while the absence of any nitrogen bands in the spectrum of the non-polar for the "excitation potential" of the oxy-aurora imposes an upper limit of 12.6 volts gen-auroral green line. With such "excitation potentials" applied to oxygen, the only wave-lengths, with two doubtful exceptions, other than λ 5577.341, known to originate in atomic oxygen, that could be emitted lie too far in the ultra-violet or in the infra-red to appear in spectrograms taken hitherto of the auroral light.

The theoretical spectral term scheme formulated for atomic oxygen provides for two low metastable states, viz., $^1S_0$ and $^1D_2$, in addition to the normal $^3P_{012}$ levels. The recent work by Bowen on spectra of nebulæ

makes it clear that so-called " metastable states " are but states of long mean life, and that provided the gases involved are at a sufficiently low density, one may expect emission of radiation, corresponding to transitions between levels ordinarily designated as metastable. In such transitions it will be noted that the electronic azimuthal quantum-number selection rules must necessarily be violated.

Under similar density conditions it is clear, from Bowen's work, that transitions are to be expected in which the inner quantum-number selection rules also may be violated. In an investigation recently carried out by McLennan, McLeod and Ruedy, photograprs were obtained with a powerful echelon spectrograph of the magnetically resolved components of the auroral green line. The structure was shown to be that of a normal Zeeman triplet, and this result combined with other evidence available, goes to show that the transition $^1S_0 \rightarrow {}^1D_2$ is the one that gives rise to the auroral green line.

In an attempt to learn something of the agent responsible for the emission of the auroral green light from clear night sky several series of observations were recently made by McLennan, McLeod and Ireton, on the intensity of light received from the zenith in the course of a single night. In this investigation two lines of procedure were followed. In the one case several spectrographs of high light power were constructed and used to photograph the green line at intervals throughout the night; in the other case, a continuous record of the intensity was obtained by means of a filter and slit moving over a photographic plate. With the most efficient of the spectrographs used it was found possible to obtain satisfactory spectrograms of the green-line radiation from the night sky with exposures as short as 30 minutes.

By co-ordinating all the results obtained during a period that included observations on nine consecutive nights it appeared that from sunset onwards there was a gradual increase in the intensity of the auroral light from clear night sky. The intensity reached a maximum at about an hour after midnight, and from that time onwards until sunrise it gradually lessenel. Conclusions that may be reached in the light of the results of the investigations summarised will be presented.

The following papers were read in title :—

Photographic Study of Detonation in Solid Explosives. By E. JONES. Communicated by J. F. Thorpe, F.R.S.

Rate of detonation is an important factor in the study of detonating explosives, as the behaviour of and the results to be obtained from a given explosive under specified conditions are intimately connected with its rate of detonation under those conditions. A method involving direct photography of a detonating cartridge possesses advantages over other methods for determining rates of detonation in that it is absolute and enables a continuous and permanent record of the progress of detonation to be obtained.

In developing such a method it was found that, under certain circumstances, interference was caused by the disturbance set up in the region surrounding the explosive cartridge. The nature of the circumstances under which interference occurred were investigated and a method of obtaining photographs free from distortion evolved. Results are given to illustrate the two stable velocities of detonation peculiar to gelatinous explosives and effect of nitroglycerine content of a powder explosive on its velocity of detonation.

Photographic records obtained with opaque explosives give rate of propagation of detonation along surface of cartridge. The detonation front inside cartridge is convex towards the undetonated portion, so that detonation is further advanced on axis of cartridge than on surface. For one explosive, the stable form assumed by the detonation front inside cartridge, and its effect on duration of detonation phenomenon over a plane transverse section of cartridge, have been determined.

On the Potential of the Electromagnetic Phenomena in a Gravitational Field. By E. T. WHITTAKER, F.R.S.

In classical electromagnetic theory, the electromagnetic field due to any number of electrons moving in any manner is determined by a theorem which expresses the scalar and vector potentials of the field in terms of the positions and velocities of the electrons. The object of the present paper is to extend this theorem to electromagnetic phenomena which take place in a gravitational field, so that the metric of space-time depends on the gravitating masses. The solution is as follows :— *Let an electron e be moving in any manner in any gravitational field, the metric being given by ds* ,

tional field, the metric being given by $ds^2 = \sum_{p,q} g_{pq} dx^p dx_q$ *: and let* π *be the proper time of the electron at the point where its world-line intersects the null-cone of any point* **P**. *Then the electromagnetic potential-vector at* **P**, *due to the electron e, is*

$$\phi_p = \frac{e}{c} \sum_{q,r} g^{qr} \left(\frac{\tau_p}{\sum g^{lm} \tau_{lm}} \right),$$

where the subscripts p, q, r, l, m, on the righthand side, represent covariant differentiations.

It is remarkahle that this formula should be so completely different from the well-known formula of classical electromagnetic theory, of which it is ,nevertheless, the true generalisation.

THE INSTITUTE OF METALS.

May Lecture on Crystals.

The annual May Lecture was delivered before the Institute of Metals in London on May 8 by Professor C. H. Desch, F.R.S., on "The Chemical Properties of Crystals," Dr. W. Rosenhain, F.R.S., President, in the chair.

After referring to the light thrown on the mechanical and physical properties of crystals by modern ideas as to the atomic structure of matter and the internal structure of the atom, the lecturer discussed the various ways in which atoms may be held together in a crystal. In rock salt the molecule had disappeared, but there were many substances which were built up of molecules in the solid as well as in the liquid state. In a few simple cases it had been found possible to calculate the forces of attraction in a particular face of a crystal, and in that way the differing chemical properties of different faces might be explained. Such differences accounted for the varying habit of crystals of the same substance grown under different conditions.

When a metal was attacked by an acid, the surface was not dissolved uniformly, but distinct "etch-figures" were produced, and the shape of those must be intimately related to the internal structure of the metal crystals. The figures might vary in the most curious way when the solvent was changed, and that was shown most clearly by large single crystals of copper.

The compounds of metals with one another have puzzled chemists, as they do not follow the ordinary rules of valency, and have many anomalous properties. The modern view of the constitution of the atom made it possible to explain them, and the relations which have been found between the forces of cohesion and of chemical affinity made it likely that there was a gradual transition from the simplest solid compounds, such as salts, through intermetallic and other compounds, to solid solutions which were regarded as mixtures.

The chemical properties of crystals were most easily illustrated by substances which did not consist of closely packed atoms, but had an open structure, such as graphite. Looseness of structure was also important for diffusion in solids, on which many technical processes depended.

THE INSTITUTE OF METALS.

President: Walter Rosenhain, D.Sc., F.R.S.

Autumn Meeting, Liverpool.

The Council of the Institute of Metals has just issued a preliminary programme of the four-day annual autumn meeting of the Institute, which is to be held this year in Liverpool.

In the course of the twenty years of the Institute's existence most provincial centres and many foreign cities have been visited, but this is the first occasion on which Liverpool has received the Members of this world-famed body of metallurgists and engineers. The proceedings will begin on September 4 with a lecture of "Non-Ferrous Metals in the Shipping Industry," by Mr. F. G .Martin, B.Sc. The mornings of September 5 and 6 will be devoted to the reading and discusion of Papers and the afternoons to visiting works of interest in the neighbourhood, the Gladstone Dock, and a large liner. In the evening of September 6 there will be a reception at the Town Hall by the Lord Mayor (Miss Margaret Beavan, J.P. The meeting will conclude on September 7 with an all-day motor trip to North Wales, during the course of which it is expected that an electric power station and aluminium works will be visited.

In addition to the Main Reception Committee (presided over by Professor C. O. Bannister, of Liverpool University) that is charged with the duty of making the generel arrangements, a Ladies' Reception

Committee has been appointed for the entertainment of lady visitors. Ladies and visitors will be entertained to luncheon and dinner by the Reception Committee.

The following communications are expected to be submitted :—

" Laboratory Experiments on High Temperature Resistance Alloys " by C. J. Smithells, D.Sc., S. V. Williams, B.Sc., and J. E. Avery, B.Sc., D.I.C.

" Corrosion at Discontinuities in Metallic Protective Coatings " by U. R. Evans, M.A.

" The Constitution of the Alloys of Aluminium with Copper, Silicon and Iron " by A. G. C. Gwyer, B.Sc., Ph.D., H. W. L. Phillips, B.A., and L. Mann.

" The Copper-Magnesium Alloys. Part III " by W. R. D. Jones, M.Sc.

"Note on Practical Pyrometry " by G. B. Brook, F.I.C., and H. J. Simcox, B.Sc.

" Eighth Report to the Corrosion Research Committee. The Corrosion of Condenser Tubes. ' Impingement Attack,' its Cause and Some Methods of Prevention" by R. May, A.R.S.M.

" The Rockwell Hardness Test " by J. E. Malam.

" Die-Casting Alloys of Low Melting Point " by T. F. Russell, Assoc.Met., W. E. Goodrich, B.Met., W. Cross, B.Sc., and (in part) N. P. Allen, M.Met.

" Work-Softening of Eutectic Alloys " by F. Hargreaves, A.R.S.M., D.I.C., F.I.C.

" Die-Casting of Copper-Rich Alloys " by R. Genders, M.B.E., M.Met., F.I.C., R. C. Reader, Ph.D., M.Sc., and V. T. S. Foster, M.Met.

" The Alpba Phase Boundary of the Copper-Silicon System " by C. S. Smith, D.Sc.

" Properties and Production of Aluminium Die-Castings " by S. L. Archbutt, J. D. Grogan, B.A., and J. W. Jenkin, Ph.D.

" Methods for Investigating Alloys of Reactive Metals " by W. Hume-Rothery, Ph. D., M.A., F.C.S.

" The Strength of a Cadmium-Zinc and of a Tin-Lead Alloy Solder " by C. H. M. Jenkins, B.Sc., A.R.S.M.

" Note on the Treatment of Aluminium and Aluminium Alloys with Chlorine " by D. R. Tullis.

Full particulars of the meeting, and membership application forms, can be obtained from the Honorary Local Secretary, Mr. H. F. Richards, B.Sc., 42, Bedford Street, or from the Secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, [illegible] London, S.W.1.

NOTICES OF BOOKS.

A Shilling Practical Chemistry. By E. J. Holmyard, M.A., M.Sc., &c. Pp. xv + 48. Price 1s. London : G. Bell & Sons. 1928.

This little book, forming a member of Bell's Science Series, is for boys and girls who are working for the School Certificate examination. The book deals with experiments of a simple kind. The author being a writer of experience and a teacher as well has left no stone unturned to give the student a clear and practical laboratory guide, which will be widely appreciated—and all for a shilling ! Particular merit lies in the simple but elegant style adopted, as will be seen from the following sentence in " model answers," p. 39 :—" I put a little of the substance into a dry, hard-glass tube and heated it. The action which took place was not accompanied by any spurting or decrepitation, so I decided not to use a lid with the crucible for the quantitative experiment." The book contains useful hints such, for example, as " Be very careful not to waste *gas* or *water*. They are both very expensive chemicals." Should the student ask his teacher to name some chemicals *less* expensive than water, the teacher would have the ready reply that in schools the expense, to put it shortly, has to take into account the total quantity used during the term. The author advocates making experiments with small quantities of material, and he could have added that manipulating small quantities cultivates skill and attention to detail, which have, perhaps, led to more discoveries in science than any other accomplishments.

F. H. L.

Journal of the Franklin Institute.

The August number of this Journal contains the following articles.—Physico-chemical considerations in astrophysics, by W. Nernst (this article might be read in connection with Jeans' book, see review in this Journal of Aug. 17, 1928); Some experimental evidence supporting the kinetic theory of gravitation (Brush's hypothesis), by C. F. Brush. Dr. Brush, a famous American inventor, supports his theory of gravitation by an observed change in the acceleration of falling bodies when dropped together, if one of the bodies is composed of a silicate of nickel, for example; the other, the control, being of lead. Few details are given, but it is stated that the substances, which fall

slower, spontaneously emit heat, but do not do so from any radioactive matter being present therein. The heat so emitted is very slight, and the Bureau of Standards (U.S.A.) is making delicate calorimeter tests. On p. 147 it is stated that—" Incidentally this research long ago led to the discovery of ' spontaneous generation of heat in recently hardened steel,' a new phenomenon, now well recognised in the metallurgy of steel.' It is curious that many years ago when electric lighting was in its infancy or at least was a small child, the writer of this notice had occasion to make temporary use of a Brush dynamo owing to a breakdown in the generator used; and just about at the same time, when grinding some large planer tools on a wet grindstone one of these became warm to the hand when it was pressed against the stone so as to chatter and emit a fairly high-pitched sound, but as soon as removed it felt quite normal in temperature. This was thought to be a physiological effect, though suggestive of something taking place in the skin of the steel. Whether this experience bears upon Dr. Brush's experiments or not it might be worth while subjecting substances, which are under molecular strain, to vibrations of various kinds including electric waves of high frequency, to see whether energy could be liberated in this way. This may be a well-known effect as the writer has not investigated the literature in this respect R. W. Wood and A. L. Loomis's (*Phil. Mag.*, Sept. 1927) experiments with high-frequency sound waves are of great interest in this connection. Now as regards the change in gravitational acceleration due to some action going on in the substance, this would require very delicate experiments so as to make sure that no change was taking place in the falling body which would give rise to a false registration of time of fall. This is no doubt fully realised by Dr. Brush, and it is hoped that he will investigate the matter exhaustively. It would not be surprising that the discovery of the mechanism of gravity, so to speak, were made in a way least expected.

The other articles in the Journal are :—Kerr effect in water due to high-frequency radio-waves, by A. Bramley; Schrot-effect in high-frequency circuits ,by S. Ballantine; Relaxation of electric fields in Kerr cells and apparent lags of the Kerr effect, by J. W. Brams and E. O. Lawrence; Effect of methods of demagnetization on the energy required to magnetise steel, by J. D. Ball; Armature reaction in multipolar direct-current dynamos, by A. P. Strom. Notes and other matters of interest follow here.

F. H. L.

Chemical Reviews.

The June number of this well-known Journal — obtainable from the English agents, Messrs. Bailliere, Tindall & Cox, 7 & 8, Henrietta Street, London—contains three articles on the atom and its periodic properties, as follows :— The structure of atoms as a periodic property and its relation to valence and ion-formation, by A. A. Noyes and A. O. Beckman; Line spectra and the periodic arrangement of the elements, by S. Dushman; The helix chemica, by B. K. Emerson. Also L. Pauling contributes an article entitled : The application of the quantum mechanics to the structure of the hydrogen molecule and the hydrogen molecule-ion and to related problems. It is satisfactory to note that Main-Smith's contribution to atomic physics is well recognised. As this is a quarterly publication there is no occasion to review it in the sense that a book is reviewed. The price per year is 23s. 6d., post free.

Radicals in Chemistry—Past and Present. By MOSES GOMBERG (Columbia University Press, New York). Pp. 22. Price 2s. 6d. Sold by MR. HUMPHREY MILFORD, Oxford University Press, Amen House, Warwick Square, London, E.C.4.

This little monograph — the Chandler Lecture delivered at Columbia University was given on December 16, 1927—by Professor Gomberg, of triphenylmethyl fame, is a valuable summary of the subject. We may quote at the outset the conclusion : " In the evolution of our organic chemical theories for 1800-1860, there was the ever-recurring refrain : Are there radicals; do they have an independent existence? The existence of radicals—*i.e.*, of part-molecules in distinct contrast to whole molecules—has been,in turn, surmised, believed in, considered as demonstrated; then the question became debatable; and finally, beginning with 1860, the independent existence of radicals was looked upon as wholly improbable. After a lapse of half a century the interest in the subject was reviewed, and the historic quest for the free radicals has been brought to a successful issue. Hitherto, the definitely recognised units in chemistry have been : atoms, molecules, ions, and electrons. And now, in addition to these

four, chemistry, it seems, has taken into account a fifth entity — free radicals." Anomalous valence may be explained on the theory of radicals; but it is a matter of definition as MgI is as much a radical in relation to MgI_2 as $(C_6H_5)_3C$ is in relation to $(C_6H_5)_3C.I$, at least this is what Gomberg says. On p. 21 it is stated that " there is spectroscopic evidence for the formation of electrically neutral molecules of the type CaCl, when the halide salts of the alkaline-earth metals are fed into a Bunsen flame (Mulliken)." Spectroscopy has revealed atom stripping, *i.e.*, electron removals, *from the outer region of the atom.* The author does not mention positive-ray analysis whereby transient compounds such as CH, CH_2 and CH_3 have been recorded (J. J. Thomson). The subject is not, however, so simple that it can be treated in quite the way one would expect as a study of this monograph will reveal. The author says that the reacting molecules first split *into respective radicals,* and these then unite to form new molecules—at least this is becoming more evident in cases which seem to demand this kind of activity. It can perhaps be remarked that the last word on the subject has *not* been said; but Gomberg's summary is of educational interest. It must be remembered, as Gomberg has indicated, that some of the substances *originally regarded as containing carbon in* the bi- or tri-valent state have turned out to be normal by doubling the formula, but there are over 100 cases in which carbon is definitely trivalent. The subject has to be studied with careful discrimination, but the above conclusion of the author need not be questioned.

F. H. L.

AIR PRE-HEATERS FOR POWER STATIONS.

About a year ago Leicester Corporation ordered two Howden-Ljungstrom air preheaters to operate in conjunction with two existing boilers at Freemans Meadow Power Station. The results obtained from that installation have been so satisfactory that the Corporation has placed a repeat order with Howden-Ljungstrom Preheaters (Land) Ltd., for preheaters for four further boilers. At the same time the Corporation has ordered the same make of preheater for pulverised fuel fired boilers now under construction for the new extension to the power station. This is another example of the repeat orders received for this type of preheater and it is interesting to note that out of a total of thirteen preheaters ordered during July, ten are covered by repeat orders.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

23,198.—Bataafsche Petroleum Maatschappij.—Process for absorbing ethylene, &c. by sulphuric acid. August 11th.

22,823.—I. G. Farbenindustrie Akt.-Ges.-Manufacture of benzanthrone condensation products. August 7th.

23,147.—Schmidt, L.—Obtaining bornyl and isobornyl ethers. August 10th.

23,091. Selden Co.—Production of monocarboxylic acids &c. August 10th.

22,795.—Soc. of Chemical Industry in Basle.—Manufacture of aminoanthraquinone derivatives. August 7th.

Specifications Published.

266,752.—I. G. Farbenindustrie Akt.-Ges.-Manufacture and production of condensation products of urea and formaldehyde.

295,142.—Standard Development Co.—Apparatus for and process of distilling hydrocarbons.

282,356.—Chemical Works, formerly Sandoz.—Process for the preparation of bile acid salts of cinchone alkaloids.

254,753.—Chemische Fabrik Auf Actien (Vorm. E. Schering).—Process for the manufacture of alkylated phenols and thei rhydrogenerated products.

Abstract Published.

292,749.—Hydrocyanic acid. — Synthetic Ammonia & Nitrates, Ltd., Billingham, Stockton-on-tees, and Ewán, T., 86, Shuna Street, Maryhill, Glasgow.

In forming hydrocyanic acid by passing vapours of formamide over a heated catalyst, the reaction gases are heated by internal heaters consisting of electrically-heatde gauzes of metals other than iron, nickel or alloys of these metals. The gauzes may be formed of brass or phosphor-bronze or of a catalytic metal such as copper, or may be covered with a layer of catalytic material such as refractory oxides. The electric heating is suplemented by external heating. The formamide vapour may be under diminished pressure or diluted. Liquid formamide may be sprayed on to the electric heaters. According to the Provisional Specification the gauzes may be formed of iron.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GLOSSINOL.

491,880.—Chemical substances used in manufactures. — British Bye-Products, Limited, Abbey House, Victoria Street, Westminster, London, S.W.1. August 15th, 1928.

SYROSAL BRAND.

490,182.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 & 4, Clements Inn, Kingsway, London, W.C.2. August 15th, 1928.

VASOPRESSIN.

490,452.—All goods in Class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Parke, Davis, and Co., Foot of McDougall Avenue, Detroit, State of Michigan, United States of America, and 50 to 54, Beak Street, Regent Street, London, W.1.

LEGULAX.

492,097.—Chemical substances prepared for use in medicine and pharmacy.—Allen & Hanbury, Limited, Plough Court, 37, Lombard Street, London, E.C.3. August 15th, 1928.

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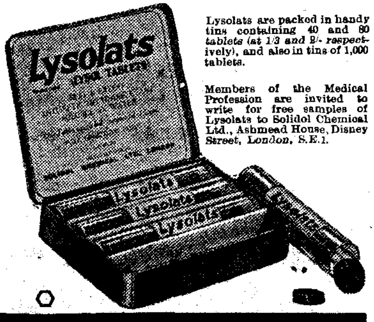

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British Association for the Advancement of Science.

GLASGOW MEETING : SEPTEMBER 5—12, 1928.

THE PRESIDENTIAL ADDRESS.

Prof. Sir William Bragg, K.B.E., F.R.S., delivered his Presidential Address before the British Association for the Advancement of Science at Glasgow on Wednesday, September 5, as follows :—

CRAFTSMANSHIP AND SCIENCE.

When nearly a century ago, the founders of our Association drew up a statement of purposes and rules they gave prominence to the words ' to obtain more general attention for the objects of Science.' Since that time we have tried continuously to fulfil our self-imposed tack, not, I hope, unwisely nor untactfully, nor without success. For this purpose we have on many occasions and in many ways endeavoured to describe the progress of our researches, and to present the consequences of discoveries as they appeared to the discoverers. With your permission, I would like this evening to add something to the story. I would claim as my justification for doin gso the fact that in the last few years scientific inquiry has advanced at a rate which to all is amazing, and to some is even alarming. On the one hand, the application of science to industry has become increasingly important and obvious, as was so clearly shown by onr honoured President of two years ago. Especially at the present time when our country is struggling to free itself from distress due partly to the war and partly to violent changes in economic conditions is it of interest and importance to consider what science is doing and can do to accelerate discovery. On the other hand, in the less material realms the applications of recent research have aroused wide interest, as may be exemplified by the influence on philosophic thought of the new discoveries in physical science, or by the effect of last year's remarkable Address from this chair.

I cannot deal in the time allotted to me with all the issues that are suggested by these considerations. I propose to limit myself in a manner which my choice of title will suggest, and in speaking of ' craftsmanship and science,' to pay attention more particularly to the relations between science and the craftsmanship of our own country. I shall not, however, be able to confine myself strictly within these limits because the entrance of science into our most material businesses cannot be considered without reference to the part that science plays in the whole range of our thoughts and actions.

The term craftsmanship requires definition. I am supposing it to mean the skill which is exercised in the production of whatever is wanted for human welfare. Imagine an island so cut off from the rest of the world that its inhabitants must depend on themselves for the satisfaction of all their desires, for their food, even if they have no more to do than pick fruit from a tree, for their clothing, for their housing, and other material things. They must also find their own means of satisfying less material cravings : for if they have intelligence they will look for means of studying themselves, their neighbours and the world round about them. Their eyes and ears will be asked to be used for the satisfaction of a sense of beauty in form and colour and sound, and their minds will try to reach out beyond what can be seen and heard. It is impossible to proceed to the satisfaction of these desires without the handling of materials, and craftsmanship begins with the skill exercised in the handling.

What the islanders succeed in achieving by their craftsmanship may justly be described as their wages, they being their own employers. If their wages are to be raised they must somehow increase one or more of the factors on which their success depends. They must be more diligent in the discovery of materials for which a use can be found; they must become better acquainted with the properties of those materials; they must develop their constructive skill. If they are too primitive to have developed the use of mechanical power they must do everything with their own hands, guided by their own intelligence and their own feeling for what is beautiful and fitting. At every step enter the qualities that go to make craftsmanship, as I would interpret the term. There is knowledge of materials, there is imagination, there is technical skill; perseverance is wanted, love of the work itself, sympathy with the use that is to be made of it, and with the user. Clearly, on the craftsmanship of the islanders will depend whether they have enough food to go round, enough clothes to wear, whether they have leisure for anything beyond the labour that satisfies their barest necessities.

And, of course, this isolated group of people will have some characteristic estimation of what they want. Their energies may conceivably be devoted only to the production of things that satisfy bodily desires, or they may be bent also on nobler things. I need not consider that point as I am not trying to picture Utopia. All that this image is meant to convey is the idea of craftsmanship and its fundamental importance. Nor is the account yet complete; far from it. It is not only that the products of craftsmanship are a necessity if the islanders are to live at all : craftsmanship has a value in itself. There is in men, more in some, less in others, the natural desire to use what faculties they possess. It is a fact that love of good work and delight in successful accomplishment are powerful motives, and when satisfied are sources of real happiness. Of all the motives that sway the world these are among the purest and best.

The power to produce in plenty what is wanted is, of course, only one of the great problems that a community has to consider. There is also the endlessly difficult question of distribution, of the manner in which each working individual is to receive his share of the wages. The two problems cannot be separated entirely : the means directed to the solution of one contribute to the solution of the other. But I must not attempt too much : science is in the first instance concerned with the production problem; the distribution problem follows.

Let us exteud our image a little; let our island be discovered and put into communication with the outside world. An exchange of craft work sets in : the islanders discover new wants that must be satisfied and they pay for the necessary imports by exporting what they make themselves. But the exports must be made to satisfy the tastes of the outside peoples or there wll be no trade. So the islanders now find that they must no longer consider their own tastes entirely : they must accommodate themselves to a more general conception which is only in part their own. It may happen that under the new conditions they become less and less self-contained. Some things which are necessary to life, such as food or clothing, may become imports, being no longer produced, at anw rate in sufficient quantity, within the island itself. And now the peaple are very firmly tied to the rest of the world; they must give that they may receive, and they must please in order that others may be willing to take. We may say that their craftsmanship is now judged more critically; and more than ever it becomes fundamental to well-being, even to existence. The conclusion I would draw from this very simple little analogy is that a people lives on what it makes or earns and that its success depends on its craftsmanship. A people cannot expect to be provided for : it has no rights.

I would ask you presently to consider the difference between the craftsmanship of an early civilisation and that of our own more complicated times. But before doing so, let me say let one or two words about the older forms.

We have a profound feeling for any example of an old craft, and for very good reasons. Among them I do not include the sentimental regret that, in some cases, a past skill seems to have disappeared. We may be sorry, but after all it is but a receipt that has been lost and may be found again any day, if proper search is made for it. Modern knowledge and methods of analysis are at least good for that much. Nor is the collector's pride of rarity the worthiest feeling that the old specimen inspires.

Our affection for it, and the reverential care with which we handle it are due to the fact that it represents to us the labour of a people, labour into which knowledge, imagination, love of beauty, technical skill have all entered. The most of what was once used in every-day life has long disappeared; even such more durable things as houses and ships, roads and cultivations may have ceased to be. The few objects that survive must be taken as examples of what has been lost. And on the showing of the student a spirit will emerge from au old vessel as great as that which issued when the fishermen of the Arabian Nights unsealed the pot that had long been lying at the bottom of the river. It is the spirit of the bygoneh people that takes shape before us.

The Greek gave exquisite form to his vase and decorated its surface with equal art. He copied from the growing things of Nature the adjustment of lines and surfaces which give the sense of fitness for a purpose. The outlines of his vases are so perfectly adjusted that their representation in a drawing will not bear alteration by the width of a line. That the Greek should with so much skill take lessous from what his perception made clear to him, and should with so much care choose his materials and mould them to his purpose is what we should expect from a nation that shows in its literature a passion for justice and harmony. The fine accuracy of his line is in agreement with his delicate sense of differences in thought and words.

The Roman developed the principle of the arch, and enough remains of what he built to show the daring and the power of his work. The great arches that spanned his public buildings seem to stand for the Roman rule and law under which the whole world might find shelter and be at peace.

The sword of the Indian workman was gradually brought to its temper by an infinite series of local applications of heat alternating with the few blows that could be skillfully given while for a moment it was in the workable state. The poverty of the craftsman's appliances, the meagreness of his little fire and the scantiness of the tools with which he made his way bit by bit to his final achievement are in consonance with his life of small details ruled by overmastering ideas.

I need not illustrate further. It is indeed well known to you all that the craftsmanship of a people is an expression of the best of its very self. It is to the underlying reason that I would draw your attention now. The mind of a nation is so expressed because its craftsmanship, interpreted in its widest sense, represents its efforts to live. Under this strong compulsion the nation produces results which range from pots to poetry, and all its products are stamped alike. That which we do ourselves is as representative as a Greek vase or a Roman aqueduct or a suit of armour from Milan. The craftsmanship of a nation is its very life. Even if we consider it only in relation to the production of material things, the state of a nation's craftsmanship is an index of its health.

As a people departs from its primitive condition so also does its craftsmanship. I would ask you to consider the nature of the change. The elements of craftsmanship in its original form centre round the individual. In his brain is the knowledge and imagination ,in his hads is the skill, and round about him lie the materials and the tools of his craft. But as the years go by it becomes impossible that all the knowledge and all the technical skill should be found in one person, and all the tools be owned by him. The craftsman becomes an association of men, a great manufacturing firm, even, we might say, a nation, if all the members of the nation contribute through Government intervention and control to the maintenance of some industry. Many hands, working in alliance which is often unconscious, are employed in bringing a product to its finished form. It is a long step from the simple workship of the old single-handed craftsman to the vast complex factory of modern industry.

If now we ask ourselves what has brought us to this new kind of modern craftsmanship, this dependence on machinery with its wealth of production, its clattering, bustling activity, and its compelling influence on the lives of all of us, we find that one simple cause has been continuously operative. It is nothing more nor less than the urgent wish of the individual to better his own condition : and in his disinterested moods, the condition of his neighbours. The change could never have been prevented.

When Hargreaves thought that by a mechanical arrangement he could manipulate several spinning wheels at one time, and succeeded, so that he had more wages to spend on his wife and children, he was obeying a universal and natural impulse. Hargreaves' neighbours being left behind in the competition for wages, pulled his house about his ears. But in the end, they, too, found themselves to be turning many spinning wheels where formerly they had only handled one. Then they, too, had more money to spend. What other turn could things have taken under the circumstances? What happened in this isolated incident is repeated again and again in every craft, and in sequence change and change marks the road that stretches far from its beginnings.

Quite apart from all considerations as to whether the new is better or worse than the old, more beautiful or less beautiful, whether it calls out the best in man as well as the older ways, or whether it fails to do so, apart from all comparisons of this kind stands the fact that the change is due to natural impulses which will not be gainsaid. The results have to be accepted. We cannot put the clock back. We cannot, let us say, wipe away the great steelworks of the world and replace them by thousands of individuals each with his single anvil and single hammer. We cannot replace the great ships of Glasgow by a multitude of little sailing boats. The plain truth is that modern craftsmanship with all its noise and ugliness is giving food and clothing, warmth and interest to millions who otherwise must die. It is ungrateful to find fault except with sympathy. Let us try in all possible ways to mend its offences and soften its hardships, but in all honesty let us recognise that we live on modern craftsmanship in its modern form. We are each and every one of us responsible for the present conditions as long as we insist on spending money to the best advantage.

At this point it is convenient to refer to a matter which would be of little importance if it did not seem sometimes to put modern

craftsmanship in a wrong light. We are continually discovering instances of the marvellous *skill* of the craftsman of thousands of years ago. There is here, however, no disheartening implication, as has sometimes been asserted, that men can no longer do what was once in their power. To those who look into what goes on in a factory or a mine, in the field or in the sea, there are innumerable instances of beautiful craft work, beautiful because of their fitness for their purpose, their balance of design, their ingenuity, their history, their growth under human perseverance and thought. Every one of us can bring to mind instances of technical skill demanding imagination and intellifence as well as manipulative power which could be set alongside any instance in history. Let me name only one : could anything surpass the drawing of fibres of quartz, finer by far than a human hair, by means of the bow and arrow? It was a feat to imagine that it could be done, to anticipate that when done it would fill so perfectly an urgent need in the construction of many important instruments, and finally, to do it.

(*To be continued.*)

MATTER. LOGIC AND SOME RESULTS OF MODERN INVESTIGATIONS OF THE ATOM.

By Dr. W. Tombrock.

In a series of essays which have appeared in the *Chemical News* (cxxxvi, 193, 289, 337; cxxxvii, 1, 66, 133) we have tried to make out what appears to be the most acceptable structure of matter, when we approach this question from a purely chemical point of view and exclusively along the path of logic.

These essays were written without a preconceived plan, partly spontaneously, partly at the kind request of the Editor of this paper. Nevertheless they form a more or less coherent and complete whole, forming part of the philosophy to which earlier chemical notions and later philosophical reflections had brought me. In so far as the ideas developed therein are original or at any rate are due to me, they have as yet appeared in no other scientific journal than the *Chemical News*. Had I been able to see beforehand to what result this work thus incidentally taken on would lead, I should have placed this series under a title : Matter and Logic.

On the basis then of a very few, very simple, very acceptable and obvious fundamental principles — axioms — which indeed wil not be contested by anyone with a sound chemical sense together with much which purely empirical knowledge of material properties and natural phenomena suggests to us, we have arrived at the following picture of the ultimate *microcosmos* which is indeed simple and sharply defined.

Matter must consist of small particles which differ in size and type of motion. We call the larger particles, with strongly rotary and less translatory motion, protons; electrons are smaller particles with less rotary and more translatory motion.

The atom is built up from protons, which are thus strong centres of rotation and around which and between which the electrons circulate . . . we therefore call the atom : proton-mill.

The stability of these proton-mills (atoms) is caused by the pressure of the ether. The ether consists of small particles which move like gas molecules. These ether particles come on and off into the proton-mills, in which they then circulate as electrons and from which they are ejected as such. Consequently the atom is to be considered as a whirlpool in the ether-ocean or perhaps better as a cyclone in the ether atmosphere. And it is this atmosphere which keeps the atoms together, which causes its stability. Indeed in an ether-free vacuum the protons, which collide with each other, would necessarily fly apart; we thus believe that we must attribute the disintegration of the radium atoms to a diminution of the the ether pressure.

This simple conception of the ultimate microcosmos leads us to a surprising explanation of gravitation, of the twofold character of the phenomenon of light, of electrical and magnetic phenomena, etc.

And the actual nucleus of our conception must be termed chemical; this is that the " bricks " of the atom, the protons, are fundamental in natural phenomena. This assumption already existed in chemistry before the radioactive phenomena had been discovered by Becquerel or radium by the Curies. The conception that atoms must be built up from similar material units is a direct consequence of a simple consideration of the chemical atomic weights; it is therefore *a true chemical notion . . . We will* now show, from the results of modern physical investigations of the atom, that this originally chemical notion has been found *to be probable to a high degree.*

We know of two kinds of atomic disintegration at present : the natural disintegration of the radioactive materials and the

artificial one brought about by bombardment with α-particles (Rutherford).

The most important results of the investigation of these two kinds of atomic disintegration are reproduced in an article by Stefan Meyer (Vienna, Institüt für Radiumforschung) in "Scientia," 1, VIII, 1928, pp. 89-98). This article bears the title : "Über die Bausteine der Atomkerne" and resulting from this we have now the opportunity of testing our notions further with experimental results. I have, however, a single remark to make beforehand. In a previous discussion of the concept of mass it was already pointed out that what is taken or calculated by physicists as mass, must not be considered as the real or true mass of the matter but exclusively as apparent mass. Mass, the quantum of matter in the ultimate particles, by itself indeed entirely *escapes our observation. What we do is to* calculate from an effect, a gravimetric or electrical effect according to circumstances. This effect penetrates to us through the contact of numerous material particles and therefore cannot any longer serve as a basis for the real or true mass. What we calculate is thus an apparent mass . . . a moment's consideration will show you this directly. It is indeed quite well possible that under certain experimental circumstances a moving ultimate material particle has no longer any demonstrable gravimetric mass, . . . so that its gravimetric mass is zero, whilst it must still possess real mass, since indeed the particle moves and movement presupposes something which moves, hence mass (matter).

What has just been said does not hold only for the mass of an ultimate material particle, but physicists may also safely insert the epithet "apparent" in the calculated size and the orbits or regions of motion of the protons and electrons. Modesty adorns a person, even the greatest.

We will now briefly recapitulate the results described by Stefan Meyer. Those who wish to be informed of the numbers or further details should consult the original (*Scientia*, August, 1928), or also the literature given by the writer : T. W. Aston (*Proc. Roy. Soc., A*, 115, 487, 1927) and E. Rutherford (*Phil. Mag.*, VII, 4, 580, 1927).

Stefan Meyer then asserts that it has been shown that *the positive atomic nucleus is not a compact unit but must consist of smaller structural units.*

The "nuclear physics" of the ratioactive substances have shown that positive α- and negative β-particles can be emitted from the central part of the atoms. *The charge* on the nucleus would only signify the excess of the positive electricity of the nuclear particles over the negative electricity of the negative fundamental particles.

This does not appear to me to be in contradiction to our own theory. That the atomic nucleus must consist of smaller structural units agrees with the conception that the atom consists of protons, primitive *chemical material units. As far as the* charges are concerned, we assume no charge for the particles themselves. Electrical charge is an effect produced by a combination of ultimate material particles, therefor by a *configuration of motion of protons* and electrous . . . or would you say it more accurately and correctly : the electrical charge is merely a symbolisation of the action which causes the measured effect.

So a positive nuclear charge is an electrical effect or action of the configuration of the protons and electrons which are considered as making up the atomic nucleus. The charge of the α-particles is an effect of four protons in an α-configuration. The charge of a β-particle is the measured electrical effect which is supposed to be produced by a β-particle. We once more stipulate : according to our conception protons and electrons themselves have no charge, they do not by themselves attract one another or repel one another; they are simply small material particles possessing rotary and translatory motion. The stability of the atom is *not* caused by electrical attraction or repulsion but entirely by the ether pressure, by the cyclonically stable form of motion which the entity must have in the ether atmosphere.

Meyer moreover says that it is remarkable that in spontaneous disintegration (radioactivity) all the positive particles appear as α-particles (He-nuclei) and not as protons (H-nuclei-chemical atomic units). In our theory this signifies that the He-nucleus must be a fairly stable configuration of motion which under favourable circumstances readily forms by itself.

One first obtained protons by the *artificial* disintegration of material containing hydrogen. Rutherford and his collaborators in Cambridge and H. Pettersson and G. Kirsch and their collaborators in Vienna later could also separate protons from : Li, Be, B, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, K, Ar, Ti, Cr, Fe, Cu, Se, Br, Zr, Sn, Te, J.

Now comes something which strikes the reporter : As is known, the artificial disintegration is attained by bombardment with

α-particles. Well now the protons ejected, shoot out not only in the direction of the projectiles but also in the *opposite* direction!

Meyer, for this reason, asserts that a sort of explosion must be produced, the incident α particle would have an igniting effect. This effect also fits well into our own picture of the atom . . . at any rate as concerns the sort of explosion . . . an ignition is not necessary.

We conceived the atom as a proton mill in which the protons rotate and electrons (ether particles) circulate between the protons. These electrons—not a few but a swarm—thereby do service as buffers between the protons. If now an α-particle as the incident projectile clears a space in the proton-mill, then for this reason protons can collide, the stabilising electron stream is interrupted and the protons splutter through direct collision with each other, as they would in an ether-free vacuum, this is to say, in all directions.

According to Meyer it has been shown that *hydrogen nuclei (protons) are present as the primary constituents of the chemical elements;* the existence of α-particles (He nuclei) in the atom has not been proved.

But in natural spontaneous disintegration with radioactive substances, α-particles are actually produced. This indicates that the α-configuration may be formed under more quiet circumstances.

In order that the calculations of the nuclear charges may come out correctly one assumes the presence of neutralised α-particles (α'-particles according to L. Meitner) and neutralised protons (π') in the central part of the atom. W. Lenz and R. Hargreaves have even considered possible arrangements of the protons in the α-particle . . . One's first idea about this would be a tetrahedral arrangement—four spheres as regions of motion of the four protons—their schemes are different.

When they carry the calculations further, then they come to the conclusion that the α'- and π'-particles occupy smaller regions of motion than ordinary He- and H-atoms. In our consideration of the case this signifies that the protons furthest inside the atom (Lise Meitner's proton-neutrons π') are more tightly packed than the protons which are situated nearer to the outside of the atom, or stated more correctly: protons which function as the structural units of the heavier elements, appear to have a smaller region of motion or sphere of action than true hydrogen protons.

The physicists have particular hypotheses to explain the stability of the atom, thus they speak of "cementings" and employ both "proton-cement" and "electron-cement" and deal also with magnetic moments (Frenkel) This, however, furnishes no explanation for us chemists since we cannot imagine what an electrical charge on an ultimate particle—considered by itself—can actually be. As far as our own explanation is concerned—we have already pointed this out repeatedly—stable ether-cyclones caused by the rotary motion of the protons, which are considered to be neutral, can be conceived without further explanation being necessary.

Meyer also mentions that H. Pettersson and G. Kirsch and later P. M. S. Blackett have succeeded in making it probable that an incident α-projectile (4 protons in an α-confifuration or perhaps in a changed state) remains attached to the nucleus of the atom which is struck, whilst furthermore only one proton is shot off. In this manner an N atom can be transmuted into an isotope of oxygen (14 + 4 - 1 = 17, valency V + 2 - 1 = valency VI). Meyer places a suitable question-mark after the rest. We will also pass over further speculations about "Packing-effects," We will only record the most important thing, the final conclusion:

"Die bisherigen Forschungsergebnisse lassen als primäre Kern-Bausteine in erster Linie Protonen und Electronen erkennen. Für die Atomgewichte kommen letztere nur in untergeordneter Weise in Betracht."

Consequently in modern physical investigations on the atom, protons or hydrogen nuclei can be recognised as the structural units of the atom, and these practically exclusively come into consideration when an explanation is given of the atomic weights. Consequently a confirmation of an old chemical idea, and of our own theoretical basis.

Bergen op Zoom,
Holland.
August, 1928.

The Commercial Secretary of the German Embassy, 9, Carlton Terrace, S.W.1., is anxious to know of British firms producing *iron pyrites, of firms roasting pyrites*, and of manufacturers of sulphuric acid.

DETERMINATION OF HIGH-BOILING PHENOLS IN A COAL-TAR CREOSOTE —CASTOR OIL SOAP DISINFECTANT.

By J. N. Taylor.

(Insecticide, Fungicide, and Caustic Poison *Control, Food, Drug and Insecticide Administration*, U.S. Department of Agriculture, *Washington, D.C.*)

The presence of high-boiling phenols in samples of commercial cresylic acid has been noted recently by Chapin. The growing tendency to utilise these high-boiling phenols in the manufacture of so-called saponified cresol solutions and in disinfectants which also contain hydrocarbon oils is probably due to the fact that the Tariff Act of 1922 permits a low rate of duty upon tar-acids which upon being subjected to distillation yield in the portion distilling below 215° C. a quantity of tar acids equal to or more than 75 per cent. of the original distillate. Such acids are now imported in large quantities and are much cheaper than cresol. Because of the low volatility of high-boiling phenolic bodies ,their quantitative determination by the method requiring steam distillation is somewhat difficult.

Commercial Sources of High-Boiling Phenols.

For many years high-boiling phenolic bodies have been obtained from the tar produced by cooling the waste bases from blast furnaces or that produced during the thermal decomposition of coal in vertical retorts. Of late the tar produced during the low-temperature carbonisation of coal has become another source of high-boiling phenolic bodies, and, according to Caracristi and to Morgan and Soule, it is being produced in increasingly large quantities. Some of these phenols find their way into commercial articles used in disinfection, markedly increasing their bactericidal efficacy.

Coal Tar Creosote Disinfectants.

Disinfectants prepared from coal-tar creocotes containing high-boiling phenols have been produced in England for some time. Burke and Caplan, in this country, have recently called attention to disinfectants prepared from creosotes obtained from low-temperature coal tar, with special reference to the pink colour that develops upon dilution with water. This is attributed to the presence of a mixture of orthodihydric phenols, including homologues of catechol. These compounds may be removed from the creosote before incorporation with a soap and water, although the colouration that they produce does not necessarily detract from the value of the article. The odour of low-temperature coal-tar creosote disinfectants, upon dilution with warm water, is distinctive, less pleasant than the odour of disinfectants manufactured from coke-oven creosotes, and somewhat more empyreumatic. The viscosity of undiluted low-temperature creosote disinfectants is greater than that of disinfectants manufantured from high-temperature creosote, while their specific gravity is lower.

As high-boiling phenols are difficultly volatile with steam, the steam-distillation method does not afford adequate means for their quantitative isolation and subsequent determination. Weiss makes use of direct distillation in determining tar acids in tar oils. In the isolation of high-boiling phenols from so-called saponified cresol solutions, Chapin successfully employs direct distillation.

Preliminary to an inquiry into the applicability of this procedure to noal-tar creosote disinfectants containing high-boiling phenols incorporated with various soaps, one containing castor oil soap was examined.

Experimental.

The tar acid used in the experiments here described was obtained from a corporation engaged in the complete gasification of coal and recovery of the by-product low-temperature tar and was submitted to fractional distillation. The portion boiling up to 280° C. was refractionated, 89 per cent. distilling between 205° and 225° C., and 11 per cent. between 225° and 280° C., the indication being that the phenols consisted mainly of xylenols with a smaller quantity of higher boiling phenols. It had a specific gravity of 1.0317 at 25°/4° C., and was incorporated with hydrocarbon oils, castor oil soap and water in the proportions stated later. The hydrocarbon oils consisted of the neutral oils extracted from a high-temperature creosote and yielded no diethyl sulphate residue. The soap was prepared by saponifying castor oil with caustic potash solution, a slight excess of alkali being present in the finished product. The sample of castor oil employed had a saponification number of 180.

Preparation of Disinfectant.

Test-tube experiments demonstrated that a stable homogeneous mixture, capable of forming a stable emulsion upon dilution, must contain the phenols, hydrocarbon oils, soap, and water in proper proportion. The proportion of phenols desired in the product influences the relative quantities of hydro-

carbon oils, soap and water that can be incorporated. It was also found that the oils had to be added slowly to the phenol-soap-water mixture at a low temperature and with constant stirring in order to effect complete miscibility. Fair results were obtained by adding a soap-water-hydrocarbon oil mixture to the phenols. Following these preliminary tests a disinfectant was made having the composition noted below :—

	Per cent. by weight
Phenols	25
Hydrocarbon oils	32
Castor oil soap	19
Water	24

The specific gravity of the product was 1.0568 at 25°/4° C.

DETERMINATION OF TOTAL PHENOLS.

Fifty grams of the disinfectant thus prepared was subjected to steam distillation until one litre of distillate had been collected. The phenols were recovered and measured according to the procedure prescribed by Chapin for the determination of phenols in coal-tar creosote dips. Duplicate determinations yielded 23.2 and 23.5 per cent., respectively, of phenols.

The technique employed in determining the phenolic bodies by direct distillation was aslo substantially that prescribed by Chapin in Bulletin 1308 for " saponified cresol solutions." Fifty grams of disinfectant was weighed into a 250 cc. Pyrex side-neck distilling flask, 2.5 grams of sodium bicarboon ate and 0.5 gram of magnesium carbonate were added, and the sides of the neck were washed down with 50 cc. of a high-boiling refined petroleum distillate that had been previously washed with alkali. The flask was connected with a Liebig condenser, and the distillate was collected in a Wiess, type 2, measuring tube. Distillation was conducted over a free flame at a slow rate until the distillate attained a deep yellow colour. The water that collected in the tube was transferred to a separatory funnel, and any phenols present were salted out, taken up in kerosene, and added to the distillate in the measuring tube. After washing with 10 cc. of 10 per cent. sulphuric acid, and discarding the acid wash, the volume in the tube was noted at 25° C. The phenolic bodies were removed with successive 80 and 60 cc. portions of 10 per cent. sodium hydroxide solution, and, after thorough draining, the final volume in the tube was again noted at the same temperature.

Duplicate determinations gave diminutions in volume of 11.95 cc. and 12.03 cc., grams and 24.8 grams of phenols per 100 grams of disinfectant, respectively. Calculated upon a volume basis, 100 grams of the disinfectant yielded 25.3 cc. and 25.4 cc. respectively (theoretical, 25.6 cc. of phenols per 100 cc. of disinfectant).

CONCLUSION.

High-boiling phenols in an emulsion-producing type of disinfectant containing a castor-oil soap may be more satisfactorily and accurately determined by distilling than hy employing steam distillaton.

A MICROANALYTICAL DETERMINATION OF SULPHUR IN ORGANIC COMPOUNDS BY TITRATION.

By BENNOSUKE KUBOTA AND SADAHIKO HANAI.

(*From the Bulletin of the Chemical Society of Japan, July*, 1928.)

INTRODUCTION.

The determination of sulphur in a few milligrams of organic material may be carried out by the methods of F. Pregl. Though the methods are quite excellent, they involve some inconveniences in the performance of experiments. For instance, the special apparatus " Micro-Neubauer crucible " must be used for carrying out the gravimetric determination and the material to be analysed must contain neither nitrogen nor halogen for the volumetric one.

One of the authors had observed that the most active part of reduced nickel decomposes organic sulphur compounds (for instance thiophen) quantitatively in the hydrogen atmosphere and, while changing itself into nickel sulphide, it absorbs the sulphur completely.

It seemed to us that this process might be carried out with all sorts of organic sulphur compounds and that it might make possible of microanalytical determination of sulphur in organic compounds by titration without any inconveniences above mentioned. Thus the studies of this process with several kinds of organic sulphur compounds were undertaken and the confirmation of the correctness of this view was obtained by the results, which gave complete satisfaction.

SUMMARY.

A microanalytical determination of sulphur in organic compounds is carried out by decomposing cautiously the material to be analysed in the hydrogen atmosphere on reduced nickel, which absorbs the sulphur completely and changes itself into sulphide, and by determining iodometrically the

reduced nickel when it is dissolved in hydrochloric acid. It was found thus that the nickel catalyst is able to be applied to the organic microanalysis of sulphur.

The Institute of Physical and Chemical Research, Tokyo.

PHOTO-ELECTRICITY.

By Sir William Bragg,
Fullerian Professor of Chemistry.
(*Royal Institution Discourse.*)

The relations between light and electricity are of unending interest. More than fifty years ago the experiments of Faraday and the calculations of Maxwell culminated in the splendid electro-magnetic theory of light, on which subsequent research has built largely and firmly.

Even in the early days of the theory there was known to exist a peculiar and special relation to which the name of photo-electricity was given. The theory gave no ready explanation of it. Light falling upon a metal plate could cause the plate to become positively charged; ultra violet behaved better in this respect than visible light. When subsequently the electron was recognised and defined, it became clear that the photo-electric effect could be explained as due to an emission of electrons from the metal under the influence of the light, and various suggestions were offered as to the nature of the mechanism. It was clear that theh absorption of energy from the electromagnetic waves of light was replaced by the energy of electrons in motion; though at that time there was no obvious relation between the quantities of energy in the two forms. As time went on it was realised that this particular transformation was not an isolated effect; it was but an instance of one of the most important and widespread processes of physics. It was to be observed not only in the case of light but of X-rays and γ-rays also; and indeed in their case it was infinitely plainer and more accessble to experiment. But it also became continually clearer that the process was not to be explained in any simple fashion, if at all, by the original electro-magnetic theory of light, or by any natural development of that theory.

At the same time a number of other physical phenomena, and especially the relation between the quality of the radiation from a hot body, and the temperature of that body, showed also that the older theories were unable to account for the facts. They could be accounted for by supposing that heat could be radiated or absorbed only in parcels of definite size, no fractions being allowed. If such an idea might be reconciled with the undulatory theory, *i.e.*, of electromagnetic waves, at least it was not contained therein. This was the beginning of the quantum period.

In 1905 Einstein published a pioneer paper in the *Annalen der Physik*, in which the quantum was given an identity even more definite than that which Planck had assigned to it in his studies on heat radiation. Light was to be regarded not as a uniform train of spherical waves, but as a flight of "quanta," corpuscles of some form to be better known on closer acquaintance. By reverting to a corpuscular theory of light he was able to connect together the new facts, which were in such apparent discord with the undulatory theory. In doing so he, of course, shut his eyes for the moment to the marvellous and most successful development of the latter theory to the explanation of such phenomena as reflection, refraction and diffraction. He would simply find a new theory to connect together the new facts; this done, the new and the old theories could be brought together in the hope of welding them together. As he announced in the title of his paper, he was going to take the heuristic point of view.

Since 1905 new discoveries of first-class importance have been made, but still there is no simple answer to the old question. The most recent and, so it s said, the most successful solution is given by the hypothesis of soc-alled Wave Mechanics, due largely to M. L. de Broglie and Dr. E. Schrödinger. It is now the subject of eager discussion in mathematical and physical circles.

My discourse is meant to be of a preparatory nature. I would like to set out the observed facts for which it is so difficult to find a common explanation, so far as it is possible to do so in the short time at my disposal. I cannot, of course, tell the whole story; I can only describe a few of the most important details of it.

Einstein begins his 1905 paper by pointing out, as a curious fact, that matter is now looked on as a collection of discrete particles, while light, which resembles matter in being one of the great phenomena, is treated as a continuous distribution in the space over which it passes; and he suggests that it would be well to consider a discrete view of light also. He then enumerates certain experimental results which would be in obvious agreement with the new theory though not with the old. Most of them are beyond our capacity to consider in the short

hour of this discourse; but two of them may well be considered by us as amply sufficient to illustrate our argument and easily demonstrable even on the lecture table.

The first of them is summed up in what is called Stokes's Law of fluorescence. When light falls upon a fluorescent substance the fluorescent light evoked is always of longer wave-lengths than the exciting light; in other words , its frequency is less. Now, if a given corpuscular theory of light is to be adopted, wave motion of a given frequency must be replaced by some characteristic of the corpuscle; and it appears that the two, and only two, characteristics of a wave-motion, namely, frequency and intensity, are to be replaced respectively by individual energy and numbers of corpuscles. This has to be done in order to explain both the results we are considering and a number that we are not. On the corpuscular theory a beam of violet light is a flight of corpuscles each having a certain energy which is proportional to the frequency of the light. A beam of green light is a flight of corpuscles each having a certain energy less than the other, because the frequency is less. It is easy to imagine that the flight of more energetic corpuscles may be degenerated by impact with the body into a flight of less energetic corpuscles. But it is very difficult to see how undulations of one wave-length can on meeting material substances be converted into undulations of a different wave-length.

A still more striking argument is found in the photo-electric effect itself. Lenard had shown three years before that when the electrons came out of the solid body under the influence of light their individual energy did not depent upon the intensity of the light, but on its frequency; the intensity affected only their number. This was an extraordinary result. It mihgt have been thought that the more energetic or violent the waves of light which caused the emission of electrons, the greater the velocity with which the electrons would start on their way. And as to the influence of frequency, it would be difficult to say how it would go; though one would not readily expect it to be the sole arbiter of the velocity. But if light was corpuscular the process, though still unexplained in detail, ceased to look strange. Each corpuscle acting independently would cause the emission of an electron. The intensity of the beam of light would depend on the number of corpuscles it contained, and their impact on the body would cause a proportionately large emission of electrons, making the photo-electric effect. And light of high frequency would on the corpuscular view cinsist of swiftly moving corpuscles which, having large energy, would cause the emission of relatively swift electrons. The whole phenomena, by its character and definiteness, spoke entirely for the corpuscular theory. Einstein explains the point perfectly clearly in his famous paper of 1905, and suggests that, if he is right, far more careful quantitative observations would be justified, as they would give an authoritative verdict on the validity of the theory which he proposed. He suggests that workers might bear his views in mind when proceeding with their experiments.

Einstein's theory must have been discussed exhaustively; but, so far as I know no allusion to it, or criticism, is to be found in the principal journals of physics for some years afterwards. In fact, it was not until seven years later that Richardson anw K. T. Compton carried out the careful measurements which Einstein suggested.

The results were in absolute accordance with the exact rules which he had supposed would govern the photo-electric effect, having based them on the less well-defined information which was available when he first wrote.

I must now be permitted to describe some experiments which I carried out in Australia twenty years ago, in conjunction with several helpers, in particular R. Kleeman and J. P. Madsen. I had been working out certain laws which governed the passage through matter of the X-rays emitted by radium; and I had tried to carry over the information so obtained to an investigation of the β and γ-rays. Now when γ-rays fall upon a substance they excite β-rays, which are electrons in very swift motion. In fact the analogy with the proto-electric effect is exact; for the rays as we know them are a form of light of very high frequency. The characteristic features of the photo-electric effect appear here also and greatly emphasised. The swift β-rays are far easier to detect and to examine than the electrons set in motion by light. The parallelism was not then so obvious at it is now, and for my own part I could not then believe in its existence. Our experiments fitted in perfectly with a corpuscular hypothesis of the nature of the γ-rays; and I supposed that the undulatory theory of light was unshakeable. I should of course, have thought otherwise if I had been aware of Einstein's paper, to which I have already referred; but it is easy to miss a single reference when one is in a very isolated laboratory, and, as I said before,

there are few if any allusions to the paper in the current literature of the years immediately following its appearance.

Our experiments in 1907 and 1908, coupled with others to which we were able to refer, led us to the following conclusions :

(1) When β-rays or γ-rays were incident on matter the energy of any resulting secondary radiations of any kind, β or γ, came from the rays. There was no "induced" radioactivity; no case of the energy of an atom being tapped. The adoption of this hypothesis simplified all further considerations of the phenomena.

(2) The so-called hard or very penetrating γ-rays produced swift and penetrating β-rays; soft γ-rays produced slow β-rays.

(3) The penetrating power or quality of the β-rays, produced by the action of γ-rays, depended only on the quality of the γ-rays, not upon the intensity or the γ-rays, nor upon the nature of the substance in which the transformation of energy took place; it was practically the same as that of the β-rays issuing from the radium itself.

(4) The β-rays produced in any substance by the action of the γ-rays moved at the outset in the original direction of the γ-radiation.

The last statement is capable of simple demonstration in the lecture room. The necessary apparatus is shown in the figure, which is taken from a paper by Madsen and myself. The radium is buried in a mass of lead, at the foot of a conical pit. Both β- and γ-rays issue from the mouth of the cone, but the former are turned aside by a strong magnet. The γ-rays pass on alone into an ionisation chamber. The beam of γ-rays is not quite free of β-rays because the latter are aroused even in the air through which the γ-rays pass on their way to the chamber, but the magnet has removed most of them. If now a carbon plate be placed in the path of the γ-rays as they enter the chamber there is a large increase in the ionisation current; the rays as they pass through the block on their way generate β-rays, which cause the observed effect. But if the carbon plate be placed on the far side of the chamber so that the γ-rays strike it on the way out, there is a relatively small increase in the current. Yet the rays must have generated βrays to very nearly the same amount in both positions of the plate; and the dissymmetry between the intensities of the "emergence anr incidence" β-rays (the one is ten times that of the other) tells us that the β-ravs are largely thrown forward as they are produced. In fact, from what is otherwise known of the behaviour of β-rays on their way through matter, we might suppose that the β-rays were thrown forward exactly in the line of the γ-rays, for the substance of the carbo screen would turn back a certain proportion of the rays, and the incidence radiation could be accounted for in this way. Nevertheless, we know now, from more accurate work which we shall presently consider, the β-rays are not so closely tied down to the forward movement, and when the γ-rays are soft and the β-rays relatively slow the difference between emergence and incidence is less marked. The experimental difference is also much less when the carbon plate is replaced by screens of higher atomic weight.

Thus again we have those characteristics which led Einstein to suggest a corpuscular theory of light in order to account for them when manifested in the photo-electric effect. Here they are displayed in an immensely enhanced degree. Consider the γ-ray as a spherical wave weakening as it spreads away from its source. It arrives at a certain atom; a β-ray springs out of the atom with an energy which is just the same, no matter how intense are the γ-rays, or how the intensity has faded with distance. Moreover, it possesses a forward momentum which could not possibly, by millions of times, be given to it by the wave, although a wave can impart a certain momentum to an encountered obstacle.

These questions of energy and momentum are even more obviously displayed in the case of the X-rays and the electrons which are concerned both in their production and their absorption. In the X-ray bulb the electron is driven with a certain speed against the anticathode, the X-ray which is thereby excited passes away and, falling on some substance, it may be far or near, sets in motion an electron which has a speed comparable with, sometimes nearly equal to, that of the original. Here again is the same kind of transformation of energy, which is simply pictured as carried, unchanging on its way, either by the β-electron or the corpuscle of the γ-ray.

I think, that in these experiments we were, though unwittingly, carrying out Einstein's suggestion that the corpuscular hypothesis deserved careful exploration; and the results were in entire agreement with his hypothesis. It was true, however, that I thought of the X-ray and γ-ray problems as distinct from that of light; and I ventured prematurely to give form to the corpuscle as a neutron, an electron compen-

sated as to its charge by the addition of a neutralising amount of positive.

In 1910 and 1911 C. T. R. Wilson published accounts of his experiments with his fog chamber. These rendered obvious to the eye those tracks of the various rays through a gas which we had endeavoured to map out by more indirect means, and entirely confirmed the conclusions that had been reached.

Wilsou's photographs of the tracks of X-rays, β-rays, and cathode rays, placed the argument on a different plane; and their beautiful detail opened up the way to quantitative measurements which had seemed impossible. It was now obvious to the eye that X-rays and γ-rays did not of themselves ionise a gas, but set in motion electrons which did so. The lengths of the tracks of these electrons in a gas could be measured, and their initial velocities be calculated therefrom; their directions of ejection could also be observed. All fitted in perfectly with the quantum theory of the X- and γ-rays, even when refinements could now be studied, as for example, the differences in velocities of ejection which were to be expected on Bobr's theory of stationary state.

In 1913 the discovery of the diffraction of X-rays by the crystal opened up a new point of view, and once more changed, or rather enlarged, the aspect of the question. It now appeared that X-rays and γ-rays in these effects behaved like long trains of spreading waves, and no clear picture of what happened could be obtained in any other way. In this matter the corpuscular theory was at sea. Even the old single pulse theory was in no better case, because it did not provide the regular succession of similar waves which was required to account for the crystal effect. The new discovery consolidated the position, linking together light, X-rays, and γ-rays as one phenomenon; if they were regarded from the point of view of the undulatory theory they were all waves which differed only in frequency. If any other view was taken, that of a corpuscular theory fo rexample, the equivalent must be expressed in some equally effective fashion. On the other hand, the simplification emphasised the difficulties of the position, since it left no escape from the necessity of finding a theory which could with equal ease and effectiveness express itself in terms either of waves or of corpuscular projectiles, whether or not this has yet been done by any of the theories now in being is indeed the question of the day; our judgment will, I hope, be assisted by the lectures that are to follow.

Meanwhile matters have by no means remained stationary since the powers of X-ray and crystal analysis have been put into our hands. With the aid of the X-ray spectrometer we can measure with extreme accuracy the wave-lengths and frequencies of X-rays. When X-rays are incident upon a substance they are to some extent scattered as such, just as a ray of light is scattered in passing through a dusty atmosphere. This is apart from the photo-electric effect, namely the production of swift moving electrons at the expense of the energy of part of some of the incident rays. The X-rays are scattered by the atoms and electrons, the light being of coarser wave lengths is scattered by the coarser particles of dust. Now when γ-rays, which are very fine X-rays, are scattered it has been often remarked that the scattered rays are somewhat softer than the originals. A. H. Compton used the spectrometer to examine if possible this softening, if X-rays could show it. They not only did so, but the experiments showed a real change of wave-length varying according to circumstauces, and obeying simple rules. It appeared, in fact, that there was a definite small change in wave-length, which depended on the angle of scattering, but not on the original wave-length nor on the nature of the scattering material. Every material returns something of both kinds; but the lighter the atom the more intense is the modified in comparison with the unmodified; at the same time, as already said, the change of wave-length is constant from substance to substance. The phenomenon is a little like that of fluorescence, but the likeness is only on the surface. But this is true of both, that the undulatory theory does not suggest a simple explanation in either case. I ought to say that Professor Raman, of Calcutta, has just announced in *Nature* that he is able to explain the Compton effect on classical lines, and promises to give his new theory in full.

On the other hand, the corpuscular theory gives at once an explanation which is relatively simple, and allows quantitative deductions to be made which are in entire agreement with the facts. If a corpuscle or "photon," to use the term which has lately been suggested, comes into collision with an electron, as it can do in traversing any material, it is possible to work out the consequences as if for an impact between two billiard balls, assuming only that photon and electron have both of them momentum and energy, the quantities being reckoned according to rules already established. The result is that the photon goes on with diminished energy; it has lost "frequency,"

and the calculated loss is exactly that which is shown as the result of experiment. Moreover, the electron ought to start off with a certain amount of energy, and when Wilson's photographs are examined the predicted tracks are found on them. Thus the spectrometer, which is based on an undulatory theory of X-rays, has established facts which are in accord with the corpuscular theory.

When we see in this way that radiation, which has always been thought of as undulatory, can on occasion display corpuscular properties, we are prompted to ask whether moving electrons—β-rays, cathode rays, and so on—which we have always considered as corpuscular, may not behave sometimes like waves? The answer appears to be in the affirmative. In America Davisson and Germor have recently described most remarkable experiments in which moving electrons are reflected by crystals in a manner bearing an obvious, though diffuse, resemblance to the now well-known reflection of X-rays, and the latter is always explained on the basis of an undulatory theory. More recently still, Prof. G. P. Thomson, of Aberdeen University, has shown that when electrons are shot through a very thin film of metal, haloes are formed upon a photographic plate on the other side of the metal, which may be explained qualitatively if the electrons act as waves in passing through the minute crystalline particles of the metal film. Prof. Thomson has promised, I am glad to say, to give us an account of this work in a Friday Evening Discourse after Easter, and this will follow naturally on the lectures by Dr. Schrödinger and Prof. Whittaker.

I hope that this brief sketch of the present position will give some ideas of its extraordinary and fascinating difficulties. Perhaps the details of the picture are sorting themselves out, and we shall see before long where we have failed to see some important point which was required for the complete resolution. When the picture is finally clear there will no doubt be atoms in it, electrons, wave motions, energies, momenta, and so on. But have we got them all rightly joined up? Perhaps wave motion belongs to more than the photon, or to something else than the photon? We can only wait.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, June 28.

The Kinetics of the Decomposition of Calcium Carbonate Hexahydrate. By B. Topley and J. Hume. Communicated by Sir Harold Hartley, F.R.S.

Measurements have been made under controlled conditions of the rate of the reaction $CaCO_3.6H_2O = CaCO_3 + 6H_2O$, the substance being in contact with water in a dilatometer. It is shown that the very large increase in velocity is due to a true temperature coefficient of reaction rate, and not to any spurious effect, such as increase of effective surface due to break-up of the crystals.

The absolute rate of propagation of chemical change in the solid has been deduced from the experimental results, and the temperature coefficient has been measured over the range 0° to 15°. The kinetics of the reaction are discussed, and an attempt is made to relate together the absolute mechanism involving the vibration frequency of the ions in the inter-face between the two solid phases and the distribution of energy among the vibrating ions.

On the Kinetic Method in the New Statistics and its Application in the Electron Theory of Conductivity. By L. W. Nordheim. Communicated by R. H. Fowler, F.R.S.

The application of the dynamical theory of gases adapted to the new quantum mechanics to the electron theory of conductivity by Sommerfeld aud Houston is investigated. With proper defintions, the dynamical theory can be worked out both for the Einstein-Bose and the Fermi-Dirac statistics in just the same way as by Boltzmann for classical statistics. The modified form of the fundamental equation of the gas theory is given, and the equilibrium states and the H-theorem are deduced from it. In comparison with the classical theory some characteristic new terms occur, but in the case of the electron theory of conductivity, they just cancel out in the usual approximation owing to the large mass ratio of the electrons and the atoms. It is, therefore, justified in that specia lcase to use the new distribution laws together with the old form of the fundamental equation.

The Fluorescence of Mercury Vapour. By R. W. Wood, For.Mem.R.S., and V. Voss.

1. The factors determining the fluorescence of mercury vapour excited by the aluminium spark have been determined. Very miunte traces of water-vapour destroy the fluorescenee, which accounts fully for previous observations supposed to show that fluorescence occurs only when the vapour is distilling.

2. All the stronger atomic lines of mercury have been found in the fluorescence spectrum, in addition to bands due to mercury molecule. The intensity of these lines has been foundd to be proportional to square of intensity of exciting light (the 2536 line excepted).

3. The effect of superheating the vapour on relative intensity of bands and lines has been studied.

4. Bands due to mercury hydride have been observed in the spectrum, as well as the carbon line 2478.

The Velocity Distribution of Photo-electrons by Soft X-rays. By E. Rudberg. Communicated by O. W. Richardson, F.R.S.

By means of a special magnetic method, measurements are obtained of the velocity distribution in the photoelectric emission from targets of carbon, aluminium, copper and silver produced by the soft X-radiation from a carbon anode. In all cases, the emission is constitnted of a group of electrons of a few volts energy and a less prominent group with energy concentrated in the region 200-280 volts. Baking at 400_3 C. generally reduces the first group by about 50 per cent., but does not affect the second.

It is proposed that the latter consists of primary electrons directly produced by the incident radiation quanta, chiefly belonging to the Carbon Kα-line (275 volts). The distribution in the first group is identical with that of the secondary emission produced by electron bombardment; it is inferred that this group results from the presence of fast primary electrons in the target. Preliminary experiments on gold-leaf indicate an absorption coefficient about 3 10^5cm.$^{-1}$. Rough calculation of total amount of primary electrons indicates a value some ten times resulting emission.

The Absorption Spectrum of Caesium. By I. M. Mathews. Communicated by S. R. Milner, F.R.S.

Photographs of the absorption spectrum of Caesium have been taken, using a concave grating of 10-feet radius of curvature. The wave-lengths of the lines of the principal series up to $m = 32$, measured with a probable accuracy of about 0.02A, are recorded, and the series constants are determined.

The Band Spectrum of Water Vapour.—III. By D. Jack. Communicated by O. W. Richardson, F.R.S.

The object of this paper is to present an interpretation of the water-vapour bands, including satellites and singlet series, in terms of the theory discussed by Mulliken in papers in *Physical Review.* Mulliken's notation is adopted, and the main branches are interpreted as due to transitions, 1A to 1B, and 2A to 2B for P and R Branches, and 1A to 1A, and 2A to 2A for Q branches.

Four of the observed series of satellites then correspond to

$$^{P}Q_{1A2B} \quad ^{R}Q_{2A1B} \quad ^{Q}P_{2A1A} \quad ^{Q}R_{1A2A}.$$

These, together with the main branches, represent all the transitions possible under the usual selection rules, as stated by Mulliken. It has been suggested by Mulliken that some satellites in the water-vapour bands violate the σ-selection rule, and this has proved to be the case. Among these are the Q satellites measured by Watson (band 3064), which correspond to Q_{1A1B} and Q_{2A2B}.

Application of the combination principle shows that the singlet series must be represented by

$$S(j) = F'_{1A}(j + 1) - F''_{1A}(j),$$

where $S(j)$ denotes lines of singlet series. This leads definitely to the conclusion that $\Delta j_k = + 2$, so that the singlet series is to be interpreted as a "double R-form" R branch, transitions in which do not follow the j_k selection rule.

New Patents.

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Latest Patent Applications.

23,799.—Beghin, P. P., and British Alizarine Co., Ltd.—Production of anthraquinone vat dyestuffs. August 18th.

23,655.—Chemical Works, formerly Sandoz.—Dyeing of effect threads. August 15th.

28,687.—I. G. Farbenindustrie Akt.-Ges. —Production of organic acids. — August 16th.

28,798.—Morgan, J. S., and Newbold and Partners, Ltd., M.—Manufacture of phosphorus, etc. August 18th.

23,612.—Price, J. B.—Production of lead oxide. August 16th.

Abstract Published.

293,185.—Hydrocarbons.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Catalytic agents; hydrocarbons.—For the catalytic conversion into hydrocarbons of mixtures of oxides of carbon with hydrogen, gases rich in hydrogen (e.g. methane), or steam, contact masses are used which contain (a) copper, silver, or gold in the metallic state or as oxide or metallic zinc and also (b) elements of the 8th group of the periodic system or compounds of such elements. The presence of carriers of low heat conductivity is avoided. The contact mass may contain, in addition to the substances specified, metals such as manganese, cerium, chromium, molybdenum, tuugsten, titanium, antimony, bismuth, and zirconium or their compounds. The initial gas may be water gas, producer gas, coke-oven gas, or the products of incomplete combustion of coal, hydrocarbons, tar oils, etc. The products are chiefly unsaturated hydrocarbons but some oxygen-containing compounds such as methanol may be also obtained.

The Latest TRADE MARKS

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BITUMETAL.

490,015.—Chemical substances used in manufactures and anti-corrosives. William Broggs & Sons, Limited, 5, Cowgate, Dundee, Scotland. August 2nd, 1928.

FORMDROPS.

491,426.—Sodium sulphide, caustic alkalies, and alkali bisulphate, all being chemical substances in Class 1.—Rhenaniakunheim Verein Chemischer Fabriken Aktiengesellschaft, 10, Reichstagsufer, Berlin, N.W.7., Germany. August 22nd.

PATENT LICENCES.

The Owners of Patent No. 222461 relating to "Apparatus for the Synthetic Production of Ammonia and Its Elements," are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. Lloyd Wise & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

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CHEMICAL STUDIES OF SYNTHETIC GALENA AS A RADIO DETECTOR. IV. — RECTIFYING PROPERTIES OF SYNTHETIC GALENA.

By WAKASABURO OGAWA.

(Abstracted from the Journal of the Society of Chemical Industry, Japan.)

As stated in the preceding reports, synthetic galena prepared by fusion of pure precipitated lead sulphide has a poor sensitivity but it is possible to activate it by several methods. Those activated with silver, thallium, aluminium, iron, yttrium and other rare metals, and alkali metals rank among the best class of all the crystal detectors, and the uniformity of sensitivity excels all kinds of the natural crystals.

The relation between sensitivity and pressure of contact was determined by using a crystal of synthetic galena containing 7.5 per cent. silver and a platinum needle welded in a glass tube in which mercury was introduced to make an electrical connection with a leading wire and at the same time to give a necessary weight to the electrode by adjusting the quantity of mercury.

Data for D.C. characteristic curve were also obtained by measuring at the same contact point, of which the sensitivity had been determined, by changing the measuring circuits with a change-over switch without disturbing the contact point.

From the results, it was concluded that, with the argentiferous synthetic galena, sensitivity is better with a smaller contact pressure to a certain limit. With a heavier contact, the current in the direction from crystal to needle increases with the corresponding voltage, but at the same time the current in the reverse direction also increases, resulting in a decreased rectification.

The D.C. characteristic curves for the synthetic galenas of various silver contents were obtained by a similar method using a platinum needle weighing 2.5 grams in order to have a constant light contact through this experiment. It was rather surprising to see that the current for a corresponding voltage in the rectifying direction was smaller in a more sensitive crystal. Thus it is known that the improvement of sensisivity by activation with silver is not caused by an increase of current in the rectifying direction but must be attributed to a decrease of current in the opposite direction.

These phenomena will be easily explained by the author's theory, which will be given in the later report, by assuming that the metallic conduction is lessened by an increase of resistance owing to a lighter contact as well as to an increase of silver content.

British Association for the Advancement of Science.

GLASGOW MEETING : SEPTEMBER 5—12, 1928.

THE PRESIDENTIAL ADDRESS.

Prof. Sir William Bragg, K.B.E., F.R.S., delivered his Presidential Address before the British Association for the Advancement of Science at Glasgow on Wednesday, September 5, as follows :—

CRAFTSMANSHIP AND SCIENCE.

(*Continued from Page* 146.)

Now we come to the point at which I would ask you to consider the relation of science to the craftsmanship which I have been trying to define. I would draw your attention to the manner in which, under the urgent drive of self-preservation, the craftsman has called scientific knowledge to his aid. Sometimes the moment has been dramatic on account of the great need of the occasion and the prompt effectiveness of the reply. When, for example, coalmining was at a low ebb because the mines were becoming waterlogged and no available power was strong enough to clear them, Savery and Newcomen made use of the new discoveries respecting the pressures of gases and vapours which Torricelli and Pascal, Papin and Hooke, had just been examining and trying to explain .The steam engine thus came into being and saved the situation. And when, at a somewhat later date, your own citizen, James Watt, by further application of the same physical laws, added fresh powers to the engine, the modern steam engine came into view, with all its applications to railways and steamships and many other marvels of to-day. In 1831 Faraday, in the course of certain systematic searchings, found out the way in which one electric current could bring another into being, the so-called electromagnetic industion. With that single day's work began the whole development of electrical engineering in its innumerable forms. I need not increase the number of my illustrations.

More often it happens that scientific knowledge enters with less instantaneous and startling effect into the history of a craft. It is only when you come to consider the various details of some modern product of craftsmanship that you suddenly realise how very closely every detail is connected with the advance of science, and indeed, to be more particular, with the scientific laboratory. Let us think for a moment of one of those magnificent ships for which the Clyde is famous. Let us survey its various parts in our minds. Its hull of steel recalls the great forges of Britain, and the wealth of research that has been spent in works and metallurgical laboratories on the nature and qualities of steels of all kinds, research which is still in progress. Within are the engines, turbines perhaps, or reciprocating, or it may be internal combustion engines, Diesel or others. What a range of inquiry and trial and development lies in every detail, depending always on principles of physical and chemical science, tested at every stage by instruments which are a craft in themselves! You may think of the screw and of its design. You may picture the curious and most efficient thrust-block by which the force of the screw is brought to bear upon the ship, and remember that Michell lately designed it on the basis of the physical laws of liquids. You look aloft and see the wireless and are reminded that this sprang directly from the physical laboratory. Your sounding apparatus is based on your own Kelvin's designs; it may be that you have fitted your ship with the wonderful and still more recent apparatus for sounding by echo, which enables her to find the depth of water, shallow or deep, even when she is travelling at high speed. The war forced this adaptation of the law of acoustics. She is sure to carry some form of refrigerating apparatus, and now we are reminded of all the investigations into the production of cold by students of science like the Frenchmen Cailletet and Pictet, by Onnes in Holland, and by Dewar, whom as befits the occasion, I will call a Scotsman rather than an Englishman. And so on, from one great feature of the ship to another, and presently from detail to detail; and you find that the whole structure is linked by innumerable ties to the research work of the laboratories. Craftsmanship in its urgent need has called upon scientific knowledge for aid, and the mighty growth is due to the response. Indeed, it is not only craftsmanship that has grown, but science itself.

If you hinder the growth of science in any way you hinder the growth of craftsmanship. Now it is an important fact that science advances over a wide front, and the

various branches of it move on together: not absolutely keeping step with each other, but preserving a general line. It has been suggested that science might refrain from development in some directions or, even as our good friend the Bishop of Ripon said at Leeds last year, we might proclain a ten years' holiday. But you cannot prevent interested men from making inquiry. You cannot prevent the growth of knowledge, you cannot even make a selection of those points of advance which will lead to certain select classes of results. No one knows what is over the hill. The vanguard moves on without any thought of what is before it. That is why, if the march of science is to be conducted in an effective and orderly way, were it only for the purposes of industry, there must always be a certain number of laboratories or parts of laboratories where scientific research has no immediate thought of possible applications.

If I read modern industrial conditions rightly the closeness of the connection between craftsmanship and science may be illustrated in yet another way. It is, I think, a fact, and a remarkable fact, that the most active of our modern industries are those which are founded on recent scientific research. The most notable is, of course, that of electrical engineering. The year that sees the celebration of our Association's centenary will witness also the ceremonies that commemorate the basic experiment of Faraday. It is difficult to sketch in a few words the great edifices that have been built upon the discovery of electromagnetic induction. We might look upon it financially and picture, as some of my hearers can do, the amount of capital involved in electrical undertakings throughout the world, electric lighting, electric transmission of power, cables and now wireless, not to mention all the minor uses to which electricity is put. The transference of matter, of intelligence, of thought, of sound, even of vision, is largely dependent on electromagnetic action. If we are not familiar with financial quantities, let us just think for a moment of the change in our lives if every electric current ceased to run; and let us realise that the whole mechanism of modern intercourse would fail and that populations born to use it would be brought to dire distress.

Though the electrical engineering industry with all its branches may be said to have its source in a single laboratory experiment, yet is has grown by the continuous adaptation of fresh streams of knowledge. The huge American corporations maintain research laboratories costing millions of pounds annually, and find that the financial return justifies their policy. The General Electric Company found that a costly research into the structure of the electric lamp repaid itself over and over again. The very important technical discoveries of Langmuir and Coolidge were consequent upon an attempt to find out what happened on the surfaces of the glass bulb and of the glowing filament. The point is that the electrical industry was not merely launched by a single discovery; it is continually guided, strengthened and extended by unremitting research.

Consider the very active motor industry. The most important of all the problems connected with the internal combustion engine is that of the nature of the explosion, the effects of varying the mixture, the movement of the gas in the cylinder before the ignition, the actual occurrences at the moment of ignition, the movement of the subsequent explosion wave. The problems are exceedingly intricate. They have been and are the subject of intense research in various laboratories in this country. The research is new and the industry is new. The construction of the engine depends on the use of alloys possessing the most remarkable properties, all of which were practically unknown until recent researches of the metallurgists brought them to light. The motor car is connected, too, with the laboratories in which chemistry and physics are applied to the study of rubber. Here again is a whole story in itself, which would tell of the work done on the intricate consequences of various kinds of mixings and of treatment, of the vulcanising and of the use of 'fillers.' Not many know the story; they are only aware that motor car tyres last longer than was once the case.

The aeroplane, like the motor car, has become possible because of the advent of the internal combustion engine; but it has a unique feature—its element of romance, its motion through the air. The laws of aerodynamics are becoming better known, and with every advance in their knowledge the efficiency of the aeroplane increases. Their intricacy is gradually resolved, but the process demands, in the first place, mathematical skill, and in the second the fascinating research that is carried on in the wind channels of our laboratories. On this splendid work the progress of the aeroplane depends. I saw not long ago in a London shop window a coloured print of a flying machine. From across the street it might easily have been taken for a drawing of a

modern aeroplane; a closer view showed still the same general spread of wings, the same whirling screws, the same discharge from the exhaust, a boat not at all untrue to modern design, and wheels to bear it when on land. Moreover the proportions were quite familiar. Yet the date was 1843. For all its resemblance to the modern aeroplane, how far it was from flying not only in time but in capacity! The difference between old and new in the form and materials of the wings may not be obvious to the casual observer, but in reality a wealth of trial and calculation lies between the crude projections of the old invention and the modern machine that flies. The turn of a line in the sectional outline of the wing may make the difference between success and failure, though it is only one of innumerable and equally essential details. The scientific worker grasps the meaning of that turn, and the airman tries it out, and that is the combination which brings success at last. The point is that the construction of the flying machine is a new industry based directly on knowledge recently acquired in the laboratories and continually growing under laboratory experiment. Everything depends on this careful, well-informed concentration on essential details.

If we enter the chemical province we find that there are thriving industries based on recent scientific discovery; instances at least as remarkable as those possessing a more physical basis. The chemical industries are so many and various that even a brief summary is beyond me; yet the whole of them are of comparatively recent origin. Quantitative chemistry is little more than a century old. And the more modern and more vigorous of the chemical industries depend on very recent chemical research, as for, example, those which deal with dyes explosives, fertilisers, rubber, artificial silk and many other things. It is the same story : the craft is based on science, and in this case very obviously so. Chemical industries are based on scientific discovery, and lean on it the whole time.

It is natural to compare the condition of the newer industries with the older industries known as basic because they have long constituted by far the major portion of the country's industrial effort and are still pre-eminent: coal and steel, cotton and wool. In some of these industries there is serious depression. What has the fact to do with science and scientific research?

It is obvious that we cannot say of any industry or craft that its condition depends only on scientific knowledge and imagination. The difficulties of the coal trade are due in large part to the powerful cause of competition. We had a good start in the knowledge of the existence of our coal deposits and in the practice of working them, in the means of distributing coal and in the methods of making use of it. We reaped our harvest. But as time went on other nations gathered way in pursuit of us; they also found coal deposits, they learnt how to work them and could even improve on our practice because they could profit by our mistakes to a greater extent than we ourselves. They had not so much old machinery to scrap. Means of transit were developed in these countries; in fact we helped to develop them, as also the industries that used the coal. Such conditions must inevitably have tended to diminish our lead. The war acted suddenly and violently in the same direction. It is reasonable, though deplorable, that the industry should find itself in difficulties. The situation is not wholly irremediable, though the older conditions can never completely return. But at least a partial retrievement is possible, and we know that various research organisations, some instituted by the State and some due to private enterprise, are grappling with the question involved. It is deeply interesting to see in what way the necessary efforts are being made, and indeed must be made.

Now, whatever is done, and in whatever way it is done, the results of such endeavour, whether related to the coal or to any other industry depend on those relations between craftsmanship and science which I have been trying to define. I would now consider these relations from one or two separate points of view. In the first instance let me say a word concerning the general connection between science and that condition in industry which is known as mass production.

It must always be the aim of an industrial organisation to devise and set going one of those systems of manufacture on a large scale with which we have become familiar in recent years. With the aid of suitably designed machinery and methods, great numbers or quantities of some article in general demand can be produced at a comparatively small running cost. Generally, however, the initial cost is heavy, for the designing of the machinery and the planning of the methods call for great experience and skill, and they demand much time spent in the acquirement of the necessary knowledge and its utilisation in design. Once the process is under way it may be

possible, and it seems to happen on a sufficiently attractive number of occasions, that a smooth and peaceful running of the machinery brings in the wished-for returns. But every such phase of production comes to a natural end. An improved process is devised, and the new displaces the old. Or it may be a factory is set up in another country where labourers can be hired more cheaply; they may be intrinsically inferior, but that will not matter if they can be drilled into the mechanical process; and, as long as the machine runs true, the standard will not fall below a certain value. The event is in accord with expectation because men will always try to improve their productivity by the use of new knowledge or more favourable conditions, so that those who fail to recognise the principle will be left behind by those who do not. The stereotyping of some process can only be fruitful for its allotted time. Mass production is in its way splendid, ministering to the necessities and conveniences of many who must otherwise have gone without. But, if it is brought to such a pitch that its processes call for little intelligence in their working, then cheap people of little intelligence will be found, in the end, to be in charge.

The relation of science to mass production is therefore both that of builder and that of destroyer. Mass productions are temporary lulls in the movement of imagination and knowledge. Much skill and thought and care may be required to arrange for one of those quiet and profitable times; the machine is set going and for a while goes by itself. But new applications of scientific knowledge, new ideas, new processes, new machines must always be in preparation. In the parks the gardeners are always nursing fresh plants to take the place of the old, and preparing them for their useful time of flowering. And so we see the meaning of the various research organisations which have been set up in the basic industries, such as the Fuel Research Board, the Cotton, the Woollen and the Silk Research Associations, the research laboratories of the steel masters at Sheffield. Much of our hope for the future is built upon their work.

If craftsmanship, to fulfil its task of providing for the people, must be continually improving its processes, then the nation that is to be successful must possess the means and the will to improve, and here we come, I think, to a notable point. May it not be said that in this country the means exist even to a remarkable degree? Our craftsmen as a whole, including all grades, are possessed of qualities, intelligence, skill, accuracy, and so on, which make improvement possible. How could our enterprises in the past have been so often successful if this had not been so? How can we be succeeding so well in respect to the new industries of the present if the capacity is not there?

Should it not, therefore, be our policy to take advantage of our country's qualities by continually seeking for fresh industries or fresh adaptations of the old? We should not surely cling unduly to older activities when they have reached the stage in which many others have learnt to do them with equal efficiency, and when we can go on to something new and, it may be, more difficult. We can, of course, bolster up old industries by political methods, and I have no wish to decry such methods as always incorrect. But clearly the best protection of all is the knowledge and skill which can enable us to produce what others must ask for because they cannot so well make it themselves.

These considerations lead naturally to a second aspect of the relations between craftsmanship and science. The improvement of craftsmanship depends in large part on the absorption and adaption of scientific discovery. How is the process to be encouraged?

(*To be continued.*)

SECTION B.—CHEMISTRY.

Phosphorescence, Fluorescence and Chemical Reaction.

ADDRESS BY

PROF. E. C. C. BALY, C.B.E., M.Sc., F.R.S.

PRESIDENT OF THE SECTION.

The phenomena associated with chemical reaction, and in particular the mechanism of chemical change, form a subject of peculiar interest. The story of the development of ideas from the birth of modern chemistry to the present day is one which to my mind forms the most attractive chapter in the history of our science. It may be that to some of those who earn undying fame by the determination of the constitution of most wondrously complex molecules, to some of those who go down to posterity as masters of synthesis and wizards of organic method, it may be that to these this chapter presents an interest that is languid. On the other hand there are many to whom it makes a great appeal because the subject matter is the fundamental basis of chemical knowledge. I confess my own allegiance

with the latter, but it is in a very humble spirit that I venture to speak upon this subject. I do so not with any confident assurance of being able to put forward a theory of chemical reaction which will embrace all the known facts and embody all the views that have from time to time been enunciated, but rather in the hopes of collecting together a number of observations which have been made in the fields allied to chemistry and appear to be worthy of consideration by those who seek to find an explanation of the mechanism of chemical reaction.

The allied fields to which I refer are those of phosphorescence, fluorescence and absorption spectra, fields which have been enriched by observations of high accuracy. These observations are of special significance in that they are concerned with the physical properties of molecules in contradistinction to those of atoms. The phenomena of chemical reaction are essentially associated with the absorption and radiation of energy, and it thus seems somewhat strange that little attempt has hitherto been made in considering the mechanism of reaction to invoke aid from the many investigations in these allied fields which obviously deal with the energy changes undergone by molecules. It will be my endeavour to show that the evidence that has been obtained from the study of luminescence and absorption spectra has a very direct bearing on the phenomena of chemical reaction, and that the hypothesis of activated molecules which forms the basis of the modern theories of the latter can be rigidly tested and examined by the former.

One of the most important theories brought forward during recent years is that known as the radiation hypothesis, which was developed independently by Perrin and by W. C. McC. Lewis. Briefly stated in an elementary way, this theory postulated that molecules in general have no chemical reactivity, and that they become reactive after they have absorbed energy. In order that a specific reactivity be introduced, a definite quantity of energy must be supplied to bring each molecule to its reactive state, this quantity being called the critical increment of energy characteristic of the specific reaction.

The fundamental basis of the radiation hypothesis was the extension of the Einstein photochemical equivalent law to include thermal radiation as well. The Einstein law states that in a photochemical reaction the absorption of the radiation takes place in the form of quanta, and that each molecule requires for its activation one single quantum $h\nu_0$, where ν_0 is the characteristic absorption frequency of the molecule in the visible or ultra-violet region of the spectrum. The conception that a single quantum of energy must be absorbed before a molecule can become activated was not only extended but also intrinsically modified in the radiation hypothesis. W. C. McC. Lewis developed from the Planck radiation formula the expression

$$d \log k/dT = Nh\nu/RT^2 \quad . \quad . \quad . \quad (1)$$

where k is the velocity constant of the reaction and N is the Avogadro constant. By treating the problem from the point of view o fstatistical mechanics, J. Rice, following the example of Marcelin, obtained an expression which, with a small simplification, may be written

$$d \log K/dT = E/RT^2 \quad . \quad . \quad . \quad (2)$$

where E is the amount of energy necessary to bring one gram molecule of a gas into its reactive state. If the lie terms in these expressions be equated we have

$$E/N = h\nu,$$

that is to say the amount of energy that has to be supplied to a single molecule to cause it to react is one single quantum of absorbable radiation. Although Lewis says that this is simply a statement of the Einstein law which is now applied to thermal or infra-red radiation, it is much more than that. The Einstein law merely states that in a photochemical reaction a molecule absorbs one quantum of radiant energy, $h\nu_0$, and then becomes activated, no assumption being made as to the difference in energy content of the inital and reactive states. The radiation hypothesis states that the difference in energy coutent of the initial and reactive states, or the critical increment of activation, is a single quantum which can be absorbed from infra-red radiation. The single increment of energy characteristic of a reaction is neither expressed nor implied in the Einstein law.

It is a simple matter to calculate the critical increment of a reaction from the observed change of the velocity constant with temperature, and by dividing this quantity, expressed in ergs, by the product Nh, to obtain the critical frequency ν. Not only must this frequency be one characteristic of the reactant molecules, that is to say one that can be observed by absorption spectra measurements, but the radiation hypothesis also demands that exposure of the inactive molecules to radiant energy of that frequency should cause the reaction to take place. As a matter of experimental fact, molecules in their inactive states do

not show any evidence of being characterised by frequencies equal to those calculated from the critical increments. This in itself is sufficiently significant to arrest attention, but when it was proved first by Lindemann and then in most elegant fashion by G. N. Lewis that molecules do not react when exposed to radiant energy, not only of the calculated frequency but of a very large range of infra-red frequencies, it was felt on all sides that the radiation hypothesis had been effectively and completely disproved.

The situation thus reached is one of considerable interest. There exist one the one hand large and increasing numbers of photo-chemical reactions which are obviously stimulated by the absorption of radiant energy. If the Planck theory stand fast, the reactant molecules must be activated by the absorption of the energy quanta $h\nu_0$, since it is well known that the frequency ν_0 is characteristic of them. On the other hand the radiation hypothesis is based on premises which appear to be theoretically sound; nevertheless it has been proved to be untenable. As a result the general consensus of opinion has swung over to activation by collision in thermal reactions. It must, however, be confessed that the present position is very far from being a satisfactory one. In the case of true photochemical reactions it is not possible to believe that activation of the reactant molecules is not produced by the direct absorption of radiant energy. In the case of thermal reactions the evidence disproves the activation by the direct absorption of radiant energy, and activation by collision bas been substituted. There are, tberefore, two accepted methods of activation, but the fact remains that thes etwo have as yet fact remains that these two have as yet general hope apparently being that any offspring will be legitimised when the union has been scientifically canonised.

When the obsequies of the radiation hypothesis had been sung, it was felt that the corpse had received decent burial. In sympathy with its parents in their bereavement, I venture to point out that this hypothesis may be divided into two parts. The first part is concerned with the critical increment of energy of a reaction, that is to say the minimum quantity of energy, or rather the exact quantity of energy, which is required to bring a molecule from its initial state to its reactive state. Unless the whole conception of different molecular states be dropped, this conception of a critical increment stands on a sure and firm basis. The second part of the hypothesis, namely, that the critical increment can be absorbed as a single quantum of energy by a reactant molecule is a pure assumption and one that would only be justified by a knowledge that the properties of molecules are in this respect identical with those of elementary atoms. The uncertainty which attaches itself to this assumption impresses me so strongly that I propose to exhume the body in order that the cause of death may be more fully investigated. There exists a considerable amount of evidence which was not before the court and this evidence is worthy of the most serious consideration.

So far as the phenomena of chemical reaction can help us, our knowledge of the physical properties of molecules, and in particular their change from one to other state of energy content, is singularly meagre, and it would seem that little more can be gained in this direction even by the most intensive study of purely chemical processes. I venture to stress this point of view because I believe that the necessary evidence can only be gained from sources of information which are independent of the processes we wish to explain. Such independent sources of information may be found in the phenomena of phosphorescence, fluorescence and apsorption spectra of compounds. Observations in these three fields are sufficiently differentiated from those of chemical reaction to be trusted to give evidence which is free from any bias. I myself believe that these observations when interpreted on the energy quantum theory constitute a mine of information which can render signal service in the quest for a comprehensive theory of chemical reaction.

The term phosphorescence is a broad one and includes both photo-luminescence and cathodoluminescence, together with certain subsidiary phenomena. The only one of these that can serve our present purpose is photo-luminescence, since a knowledge is essential of the frequency of the activating radiation as well as that of the emitted radiation. It is not possible to give here any detailed account of the many observations, both qualitative and quantitative, of the phenomenon of photoluminescence, but particular attention may be directed to one or two of these which have a special significance in the present connection.

It would perhaps be advisable first to describe very briefly the principal facts which have been established. In the first place the molecules of the phosphore are brought into a state of higher energy content, or the activated state, by the absorption of radiant

energy. The phosphorescent emission is the radiation of energy during the change of the molecules from the activated state to the original state, and this energy is equal in amount to that gained during the activation. The persistence of the phosphorescence, that is to say the period of the time during which the luminescence persists, is a measure of the stability of the activated state. The more stable is the activated state, the longer is the persistence, and *vice versa*. The intensity of the luminescence is in inverse ratio to the persistence. After a definite quantity of energy has been absorbed by the phosphore, then in the radiation of that quantity in the form of phosphorescence the velocity must affect the persistence and intensity in opposite senses. Since the phosphorescent emission is the integration of the individual radiation of a number of molecules, the intensity decreases with time as the number of molecules in the activated state becomes smaller. If the intensity of any time t be measured in relation to the initial intensity $(t=0)$

then $$I^{-\frac{1}{n}} = a+bt$$

and in the majority of cases $n=2$.

The stability of the activated state is determined both by the temperature and by the concentration of the phosphorogen in solid solution in the diluent. The higher is the temperature, the less stable is the activated state, and there always exists an upper temperature limit, characteristic of every phosphore, above which no phosphorescence can be observed. The stability of the activated state is the greatest with a pure substance, and in order to observe phosphorescence at temperatures below the upper limit, it is necessary that the phosphorogen be in dilute solid solution in some diluent. This was first observed by Lenard and Klatt with their alkaline earth sulphide phosphores, and more strongly emphasised by Urbain and Bruninghaus in the case of the rare earths.

The foregoing is a brief account of the characteristics of photoluminescence, and we may now consider in detail one or two of these, selecting as the first the relation between the frequencies of the exciting radiation and the emitted radiation. In the alkaline earth sulphide phosphores the phosphorescent radiation is very often complex in the sense that it consists of several separate emission bands. Lenard and Klatt, however, satisfied themselves that each emission band is characteristic of a single activated state, since each has its own frequency of activation and its own upper temperature limit. The relation between the absorption band at which activation takes place and the emission band after activation is an intimate one, and it has been shown by later work on less complex phosphores that the absorption and emission bands have structures which are analogous.

(*To be continued.*)

THE COLLINSICS OF MINERALS, III.

By Hawksworth Collins, B.A. (Camb.).

The first line of each collinsic contains (i) its number, *i.e.*, the number representing the position of its publication; (ii) its chemical formula; (iii) its theoretical specific gravity; and (iv) its experimental S.G.

The second line gives (between the brackets) the relative volume of each atom in the substance. These relative volumes are the Fundamental Constants of Nature, as shown in the *Chemical News*, 1926, cxxxiii, 161.

The third line gives the theoretical refractive index of the molecule, and also its experimental R.I., which are always within one per cent. of one another.

The fourth line gives the relative refractivity of each atom, *i.e.*, the relative effect which each atom produces upon a ray of sodium-light passing through it.

When the molecular weight is divided by the sum of the atomic volumes within the brackets, the result is always equal to or within one per cent. of the experimental S.G.

The sum of the atomic refractivities always corresponds to at least four figures with the molecular refractivity of the substance as calculated in an entirely different way in the second line.

In other words, in each collinsic the atomic volumes (between the brackets) with their corresponding atomic refractivities (given directly under them) are the same in all minerals. The proof that these have been correctly found consists in three successful mathematical operations in the case of each mineral:—

(a) The molecular weight divided by the sum of the volumes must give the correct S.G.

(b) The sum of the volumes, when multiplied by $\mu - 1$ must give a particular number.

(c) The sum of the refractivities must give the same particular number correct to four figures.

Pectolite (No. 36) will now be considered

as an example. Its experimental S.G. is given by Miers as 2.73. If the mol. wt. be divided by the mol. vol., which is the sum of the atomic vols. given in the second line, the result is 2.73. Before this operation could be successfully performed, of course it was necessary to discover the exact relative volumes at 15° C. of the combining atoms.

If the same mol. vol. be multiplied by 0.6121 $(\mu - 1)$ where μ is within 1 per cent. of the experimental value, the result corresponds with the sum of the atomic refractivities. Before this operation could be successfully performed, of course it was necessary to discover the exact refractivity at 15° C. of each atom.

The relative volume of Na is 11.865 in hundreds of minerals and its corresponding O.R. is 3.865 always. These figures have already occurred 13 times in the 35 preceding collinsics.

The rel. vol. 13.25 of Ca, which has the same figures for its O.R., has not occurred before, but it will appear later in several minerals. The rel. vol. 17.61 of Si with its corresponding R.I. 9,625 has already occurred 7 times. The rel. vol. 4.45 of oxygen with its corr. O.R. 1.747 has already occurred 19 times.

The volume 2.51 of oxygen with its corr. O.R. 1.346 has already occurred 162 times. The volume 5.76 for H in hydroxyl with its corr. O.R. 2.613 has occurred 76 times. It appears twice in each molecule of crystallised water.

The Gladstone-Dale formula is employed; as it has been found to be the correct one for certain reasons, which cannot be stated at present. These reasons will be demonstrated gradually by future collinsics, and will be evident to any scientist who studies the matter.

In previous papers by the investigator the Lorentz formula was employed. This led to nothing, and has therefore been discarded.

The importance of the collinsics partially consists in the fact that, being evidently correct, they lead to further exact knowledge with regard to the Constitution and Structure of Atoms.

The proof that the three relative volumes 7.53, 4.45 and 2.51 of oxygen are correct was given in the *Chemical News*, 1924, cxxviii, 280.

TABLE III.

THE COLLINSICS OF TWELVE MINERALS.

	Theor. Column	Obs. Column	
(25) Bauxite $Al_2 + O + O + O + H_2O$			
$27.049 = 0.5802(9.05_2 + 7.53 + 4.45 + 2.51 + 14.03)$	**2.57**	2.55	D
$27.049 = 7.865_2 + 1.654 + 1.747 + 1.346 + 6.572$	**1.5802**	1.57	M
(26) Spinel $Mg + Al_2 + O + O_3$			
$26.546 = 0.7062(7.51 + 9.05_2 + 4.45 + 2.51_3)$	**3.77**	3.77	Jere
$26.546 = 5.031 + 7.865_2 + 1.747 + 1.346_3$	**1.7062**	1.7155	D
(27) Anorthite $Ca + Al_2 + Si_2 + O_2 + O_6$			
$58.558 = 0.5822(14.54 + 9.05_2 + 18.91_2 + 7.53_2 + 2.51_6)$	**2.764**	2.763	Rose
	1.5822	1.588	S
		1.576	S
$58.556 = 10.52 + 7.865_2 + 10.461_2 + 1.654_2 + 1.346_6$			
(28) Heulandite $Ca + Al_2 + Si_6 + O_6 + O + O_9 + (H_2O)_3$	**2.1965**	2.1963	Jere
$132.523 = 0.5089(14.54 + 9.05_2 + 18.91_6 + 7.53_6 + 4.45 + 2.51_9 + 14.03_3)$	**1.5089**	1.505	D
$132.517 = 10.52 + 7.865_2 + 10.461_6 + 1.654_6 + 1.747 + 1.346_9 + 6.572_3$			

(29) Microcline $K + Al + Si_3 + O_8$ **2.57** 2.57 I

57.503 = 0.5317(22.29 + 9.05 + 18.91$_3$ + 2.51$_8$) **1.5317** 1.530 S; 1.535 M

57.506 = 7.49 + 7.865 + 10.461$_3$ + 1.346$_8$

(30) Orthoclase $K + Al + Si_2 + Si + O + O_7$ **2.555** 2.555 D

57.071 = 0.5246(22.29 + 9.05 + 18.91$_2$ + 17.61 + 4.45 + 2.51$_7$) **1.5246** 1.5237 D; 1.5260 D

57.07 = 7.49 + 7.865 + 10.461$_2$ + 9.625 + 1.747 + 1.346$_7$

(31) Analcite $Na + Al + Si + Si + O_2 + O_4 + H_2O$ **2.278** 2.278 T

47.080 = 0.48755(11.865 + 9.05 + 17.61 + 18.91 + 7.53$_2$ + 2.51$_4$ + 14.03) **1.48755** 1.4874 D

47.080 = 3.865 + 7.865 + 9.625 + 10.461 + 1.654$_2$ + 1.346$_4$ + 6.572

(32) Laumontite $Ca + Al_2 + Si_4 + O_4 + O_8 + (H_2O)_4$ **2.245** 2.25 D

108.427 = 0.5178(14.54 + 9.05$_2$ + 17.61$_4$ + 7.53$_4$ + 2.51$_8$ + 14.03$_4$) **1.5178** 1.513 S; 1.525 S

108.422 = 10.52 + 7.865$_2$ + 9.625$_4$ + 1.654$_4$ + 1.346$_8$ + 6.572$_4$

(33) Natrolite $Na_2 + Al_2 + Si_3 + O_3 + O_2 + O_5 + (H_2O)_2$ **2.23** 2.23 M

83.179 = 0.4874(11.865$_2$ + 9.05$_2$ + 18.91$_3$ + 7.53$_3$ + 4.45$_2$ + 2.51$_5$ + 14.03$_2$) **1.4874** 1.48866 D

83.173 = 3.865$_2$ + 7.865$_2$ + 10.461$_3$ + 1.654$_3$ + 1.747$_2$ + 1.346$_5$ + 6.572$_2$

(34) Quartz $Si + O_2$ ***2.651*** *2.651* *B*

12.315 = 0.5442(17.61 + 2.51$_2$) **1.5442** 1.54418 D

12.317 = 9.625 + 1.346$_2$

(35) Christobalite $Si + O_2$ **2.263** 2.27 D

13.119 = 0.4949(17.61 + 4.45$_2$) **1.4949** 1.486 S

13.119 = 9.625 + 1.747$_2$

(36) Pectolite $Na_2 + Ca_4 + Si_6 + O_2 + O_{15} + H_2O$ **2.73** 2.73 M

148.722 = 0.6121(11.865$_2$ + 13.25$_4$ + 17.61$_6$ + 4.45$_2$ + 2.51$_{15}$ + 14.03) **1.6121** 1.595 S; 1.634 S

148.736 = 3.865$_2$ + 13.25$_4$ + 9.625$_6$ + 1.747$_2$ + 1.346$_{15}$ + 6.572

ERRATA IN PAPER II.

In *Grossularite*, Si_3 should stand for Si_2

The 19th mineral is Enstatite, not Enstatie.

In *Forsterite*, 5.031$_2$ should stand for 5.021$_2$

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THE HISTORICAL COLLECTIONS OF THE LATE PROF. E. F. SMITH.

The priceless collection of chemical memorabilia assembled by the late Dr. Edgar Fahs Smith, who was internationally known as a chemist and was Provost of the University of Pennsylvania for ten years, has been presented to the University by his widow, Mrs. Margie A. Smith, and will be preserved intact in its present setting in the Harrison Chemical Laboratory, it was announced at the University.

With the acquisition of the collection which will be known as " The Edgar Fahs Smith Memorial Collection in Historical Chemistry," the University is making special arrangements to safeguard it, following which it will continue to be accessible to visitors and students of the history of chemistry, many of whom during Dr. Smith's lifetime had frequent recourse to it for study and research work.

Eventually it is expected the University will create a fund, the interest of which will be devoted to the perpetual maintenance of the collection, and additions will be made to the collection from time to time, if possible, so that it may be an ever-growing asset to the Chemical Department of the University.

Dr. Smith, who died on May 3 this year, had served as Emeritus Professor of Chemistry at the University after resigning the Provostship in 1920. He was a former President of the American Chemical Society and of the American Philosophical Society, had served as a member of the United States Assay Commission; as Trustee of the Carnegie Foundation; and as technical adviser to the Disarmament Conference, and was the author of more than 200 scientific papers as well as numerous books on chemistry.

In 1926 he was awarded the Priestley Medal bestowed by the American Chemical Society for outstanding achievement in the science of Chemistry, and he also was the recipient of the Elliot Cresson Medal from the Franklin Institute " for distinguished contributions to electrochemistry," and the Chandler Medal from Columbia University for contributions to historical chemistry. In addition, France made him an Officer of the Legion of Honour " for distinguished services to chemistry."

Dr. Smith became interested in the history of chemistry early in his career and his private collection of chemical memorabilia, which is said by many authorities to be the best of its kind, was compiled during years spent in patient search in all parts of the world for rare items in which he was interested.

The collection, as presented to the University, comprises three main divisions. The first contains about 500 autographed letters and manuscripts of eminent chemists of all nationalities; the second is made up of approximately 1,000 portrait prints and engravings of prominent chemists from the days of the alchemists to the present, and the third consists of nearly 1,000 books on alchemy and chemistry.

In addition, there are a number of chemical preparations and a variety of chemical apparatus which Dr. Smith had accumulated during his career as teacher and research worker, and an unusually rare collection of books and manuscripts relating to the history of the University of Pennsylvania and the lives of outstanding alumni and members of the faculty.

Of Dr. Smith's collection of books on alchemy and chemistry the majority are in their original bindings and many are printed in Latin, German and old French.

The oldest book included is Geber's " Alchemy," which was printed in Nuremburg in 1545, while probably one of the rarest in the collection is the " Theatrum Chemicum Britannicum" printed in London " at the Angel in Cornhill " in 1652. This work was edited by Elias Ashmole and contains a series of old English poems on alchemy, one of which is by Geoffrey Chaucer.

Letters from eminent chemists of all nations from the earliest times down to those of Pasteur and Madame Curie are among the autographed manuscripts found in the collection. Notable among these is one addressed by Joseph Priestley in 1792 to the members of the National Assembly of France.

In this letter, Priestley accepts the honour which they do to him by making him a " citizen of France," but declines " nomination to the approaching National Convention."

Dr. Smith had long been interested in the life and works of Priestley and in 1926 had deposited in the Priestley Museum at Northumberland, Pa., a collection of Priestleyana which was said to be the largest of its kind and which included Priestley's balance and the original manuscript of " Priestley's Memoirs."

In 1898 when Dr. Smith was elected Vice-Provost of the University of Pennsylvania he became intensely interested in the early

history of the University and his zeal in collecting material bearing on that subject soon resulted in his accumulation of a variety of rare items, many of which cannot be duplicated elsewhere.

As a result, although his collection will be known as one in Historical Chemistry, it will command general interest because of its many autographed letters, rare prints and historical documents associated with the early history of the country.

Included among these is an autographed letter of Benjamin Franklin, founder of the University, and also one from William Smith, who was the University's first Provost and a close friend of Franklin's

In addition to Franklin's letter, there are also signed letters of nine other men who were either Trustees or alumni of the University and who signed the Declaration of Independence, the list comprising Robert Morris, George Clymer, James Wilson, Benjamin Rush, Thomas McKean, John Penn, Francis Hopkinson, William Paca and James Smith.

Along with these may be found a letter from Tench Tilghman, Washington's aide-de-camp, who was a graduate of the University, and a letter from General Anthony Wayne, also an alumnus of the University.

The Wayne letter, said to have been written from Valley Forge, was addressed to Colonel Butler. In it, General Wayne plainly disclosed the sufferings and discomforts of the Continental troops by writing: "My dear Butler,—Why don't you come and see me. Pray send a pair of Woollen Socks by Larry. I can stand to-day —probably may limp about to-morrow. Come and dine and tell me the news. Adieu. —Yours sincerely, Anthony Wayne."

Books written by early faculty members of the University, photos of Provosts and Vice-Provosts, and a valuable group of early American prints and engravings, notably those by David Edwin, one of the earliest and most skilled engravers in the country, are additional features of the collection.

Many of these items, as well as those in his collection of chemical memorabilia were presented to Dr. Smith by friends all over the world who were familiar with his zeal for collecting historical material, but the majority were found by Dr. Smith personally.

As an example of the patience and perseverance which he displayed in his quest for items which he particularly desired it is said that for more than ten years he prosecuted a diligent search for a print of Francis Alison, who was Vice Provost of the University from 1755 to 1779 and a likeness of whom he wanted for his collection. The search was finally successful.

When the Harrison Chemical Laboratory was erected at the University in 1894, Dr. Smith selected two rooms in the laboratory for his offices and these rooms he continued to occupy until his death, making them the depository for his collections.

As his collections increased, these two rooms gradually began to assume the appearance of a chemical museum, and as news of the variety and rarity of Dr. Smith's Collections became known among chemists and others, the room became a Mecca for students of the history of chemistry from all over the world.

So important did his treasure house loom in the eyes of chemists that when the American Chemical Society met in Philadeplhia in 1926, an exhibition of historical chemistry was held in Dr. Smith's office and hundreds of chemists, including Professor Bertrand, Head of the Pasteur Institute in Paris, Dr. Ernest Cohen, of Utrecht, Holland, Prince Conti, of Italy, and Professor Sapojnikoff, of Leningrad, Russia, were in attendance.

According to University of Pennsylvania authorities, a number of letters expressing the hope that Dr. Smith's collections would be preserved intact in their present setting and made accessible to interested students of chemistry have been received since Dr. Smith's death from men prominent in chemical circles.

As a result, following Mrs. Smith's generosity in presenting the collections to the University, the work of fire-proofing and otherwise safeguarding the rooms in the Harrison Laboratory which contain the collections is being carried on as rapidly as possible so that the collection may again be made available to those interested in research in chemistry.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, June 28.

Observations on the Height of the Ozone in the Upper Atmosphere. By P. Götz and G. M. B. Dobson, F.R.S.

Some 50 measurements have been made of the height of the ozone layer in the upper atmosphere over Arosa (Switzerland). It appears that the height is greatest when the amount of ozone is large, and least when the amount is small. There is also evidence

of an increase of height from autumn to spring. Further measurements are necessary to confirm these conclusions. The average height seems to be between 35 and 40 kms.

Am Improved Method of Ultra-Violet Polarimetry. Anomalous Rotatory Dispersion of Sodium Tartrate. By T. M. Lowry, F.R.S., and M. A. Vernon.

Improved sensitiveness has been obtained by measuring with a densimeter the density of the photographic image of the middle and outer portions of a triple field. By plotting the ratio of the densities against the readings of the analyser-scale, the setting which gives equal photographic densities can be read off within about 0.005°. In this way a curve of anomalous rotatory dispersion has been plotted for a 1 per cent. solution of sodium tartrate, which gave a maximum dextrorotation of only 0.5°.

Antiseptic Compounds; Some Further Derivatives of Anil-Quinoline. By J. B. Cohen, F.R.S., C. H. Browning, F.R.S., S. Ellingworth and R. Gulbransen.

Compounds of larger molecular weight have been prepared and tested. Owing to limitations of solubility, no great increase in mass of the quinoline portion of molecule was possible, but powerful antiseptics were obtained, by condensation of various nitroso compounds with methochlorides of methyl and ethyl quinaldyl carbamates.

Addition of further aromatic nuclei to the benzene portion of the molecule diminishes antiseptic potency, but where the additional nucleus is reduced, thus assuming an aliphatic nature, activity is greater. Particularly potent substances are obtained by condensation of nitroso derivatives of tetrahydro-quinoline and methyl tetrahydroquinoliue with quinaldine compounds.

Products were also prepared from nitroso mono-methyl aniline, practically as active as the corresponding dimethylamino compounds, whereas primary amino derivatives have been shown to be less potent. Thus in the anil-quinoline series, the distinction appears to lie between those substances containing, on the one hand, a primary basic group, and, on the other, a secondary or tertiary group, in the benzene nucleus.

Inhibition as a Reflex Accompaniment of the Tendon-Jerk and of other Forms of Musculqr Response. Communicated by Sir Charles Sherrington, F.R.S.

Close examination of cessation of tonic posture action currents during a tendon jerk in the same muscle reveals that the cessation is an inhibition. The silence is found by analysis to be due in part to a refractory period of motor units involved, combined with a proprioceptive reflex inhibition of all units of centre, caused by stimulation of some end organ in the muscle by the motor excitation. There is reason to believe that this end organ is the muscle spindle, and that every reflex activation evokes a proprioceptive inhibitory effect upon the muscle.

Vital Staining of Normal and Malignant Cells. I. Vital Staining with Trypan Blue and the Cytoplasmic Inclusions of Liver and Kidney Cells. By R. J. Ludford. Communicated by J. A. Murray, F.R.S.

By the cytological technique described it is possible to demonstrate in kidney and liver cells of animals stained intravitally with trypan blue :—

(*a*) Dye droplets and mitochondria, (*b*) dye droplets and Golgi apparatus.

No definite relation can be established between dye droplets and mitochondria. The dye droplets make their appearance in relation to the Golgi, and when formed break away from it. The formation of the droplets resembles the formation of secretion granules in gland and cells.

The observations suggest a functional inter-relation between the Golgi and the mitochondria.

THE INSTITUTE OF METALS.

Annual Autumn Meeting, Liverpool.

September 5 & 6.

Eighth Report to the Corrosion Research Committee. By R. May, A.R.S.M. (Investigator to the Committee).

The Report dealt with some further investigations of "impingement attack" which were undertaken in order to interpret the results of certain tests on condenser tubes, and, in particular, to explain the relationship which appeared to exist between the effects o fintermittent cavitation in the water, and the effects of air-bubble impingement.

Part I. dealt with the behaviour of protective films under various conditions of impingement. A method of studying this behaviour by measurements of the "film potential" is described in detail. The method is particularly useful for comparing the healing powers of the natural protective films on different condenser tube alloys, and should be of assistance in the development of specially resistant condenser tubes.

Part II. described some experimental work which shows that, when there is no intermittent cavitation, "impingement

Abstract Published.

298,208.—Formaldehyde.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

In the manufacture of formaldehyde from methanol and air, the reagents are preheated separately by regeneration and are then mixed at a temperature below the temperature below the temperature of reaction. The example refers to a plant for the catalytic production of formaldehyde from methanol and air in which the reaction products, leaving the contact chamber at a temperature of about 500° C., pass first in contact with a silver coil in which methanol is vaporised and the vapour preheated, and then into a copper regenerator in which air is pre-heated. The methanol vapour and air, pre-heated in this way to temperatures of about 150° C. and 120°C. respectively, are mixed and brought to reaction.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

YESSALL.

490,700.—Chemical substances prepared for use in medicine and pharmacy.—The English Grains Company, Ltd., Shobnall Road, Burton-on-Trent. August 29th.

POLSTANE.

493,477.—All goods in class 1 which includes acids, potash, salts and other chemical substances used in manufactures.—William R. Todd & Son, Ltd., Marfleet Avenue, Marfleet, Hull, Yorkshire. August 29th.

493,709.—Monogram of the letters F B C on a check background, for chemical substances prepared for use in medicine and pharmacy.—Heppells, Ltd., 16, Grosvenor Place, London, S.W.1. August 29th.

492,661.—Reproduction of a painting of the late J. M. Smith for chemical substances prepared for use in medicine and pharmacy.—J. M. Smith & Company (London) Ltd., Hampton Chemical Works, Arthur Street, Old Kent Road, London, S.E.15. August 29th.

PATENT LICENCES.

The Owners of Patent No. 222461 relating to

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BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN AUGUST, 1928.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during August has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 529, of which 429 were from merchants or importers. To these should be added 12 cases outstanding on the 31st July, making a total for the month of 541. These were dealt with as follows:—

Granted—483 (of which 471 were dealt with within 7 days of receipt).
Referred to British Makers of similar products—36 (of which 22 were dealt with with 7 days of receipt).
Outstanding on 31st August—22.

Of the total of 541 applications received, 493, or 91 per cent., were dealt with within 7 days of receipt.

CANADA'S IRON AND STEEL OUTPUT AT HIGH LEVEL.

Canadian production of pig iron during July amounted to 95,422 long tons, a decline of 2 per cent. from the record for the year at 97,379 tons, established in June. July production was, however, 87 per cent. above the corresponding month of last year when 50,997 tons of pig iron were produced.

The Report of the Dominion Bureau of Statistics on production of iron and steel in Canada points out that cumulative production of pig iron for this year to July 31 was 24 per cent. ahead of the corresponding period of last year, this year's figure of 563,485 tons comparing with 454,710 tons for the first seven months of 1927.

In steel output, Canada's production of steel ingots and direct steel castings at 82,807 tons in July fell 29 per cent. below the output of 116,530 tons for the previous month but was 50 per cent. above the 55,250 tons reported for July of a year ago. In cumulative output for the year to date Canada's production of steel appears at even better advantage than that of pig iron, 731,145 tons being produced to July 31 this year against 542,560 tons in the first seven months of 1927, a gain of 24.8 per cent.

British Association for the Advancement of Science.

GLASGOW MEETING : SEPTEMBER 5—12, 1928.

THE PRESIDENTIAL ADDRESS.

Prof. Sir William Bragg, K.B.E., F.R.S., delivered his Presidential Address before the British Association for the Advancement of Science at Glasgow on Wednesday, September 5, as follows :—

CRAFTSMANSHIP AND SCIENCE.

(*Continued from Page* 164.)

We here come to a point which must be emphasised with all possible vigour, because its importance is not always realised. Scientific knowledge and experience if it is to be of full service must be in direct practical contact with the problem that is to be solved. This must be clear to every one of us from actual experience. If you have expert knowledge on any subject and your advice is asked, your first instinct is, as you all know, to ask to be allowed to see for yourself. It is only when all the circumstances are clear to you in their relation to the difficulty that the solution is likely to suggest itself. And it may take much watching and patient observation before you are successful. It is the combination of actual experience with scientific knowledge that is essential. As the principle is so fundamental, I may be allowed to illustrate it by an actual experience :—

It was in the early years of the war that a body of young scientific students from our Universities was assembled for the purpose of testing on the battlefield the value of such methods of locating enemy guns as were already known. In their mutual discussions and considerations it became clear to them that the great desideratum was a method of measuring very exactly the time of arrival of the air pulse, due to the discharge of the gun, at various stations in their own lines. If the relative positions of the stations were accurately known it would then become a matter of calculation to find the gun position. But the pulse was very feeble : how could it be registered? Various methods were considered, and among them was one which no doubt seemed far-fetched and unlikely to be successful. A fine wire is made to carry an electric current by which it is heated. If it is chilled, for example, by a puff of cold air, the resistance to the passage of the current increases, and this is an effect which can be measured if it is large enough. If, then, the hot wire could be made to register the arrival of the air pulse from the gun a solution of the problem was in hand. No doubt this method occurred to several members of the company; it was certainly turned over in the mind of one of them who had had considerable experience of these fine heated wires. They had been in use about thirty years, having geen employed for the measurement of temperature in many circumstances where their peculiar characteristics gave them the supremacy over thermometers of the ordinary form. But, and this was the important point, was it to be expected that the effect, though it must be there, would be big enough to see? Could the faint impulse from a gun many miles away produce an obvious chill in a hot wire? On first thoughts it did not seem likely, and the suggestion lay in abeyance.

But it happened that one summer morning an enemy aeroplane came over at daybreak on a patrolling expedition. The officer of whom I have spoken lay awake in his bunk listening to the discharges of the anti-aircraft guns and the more distant explosions of their shells. Every now and then a faint whistling sound seemed to be connected with the louder sounds. The wall of the hut was of felt; it was in poor condition and there were tiny rents close to his head as he lay. The gun pulses made a feeble sound as they came through. This set the officer thinking; if the pulse was strong enough ta make a sound, it might be strong enough to chill a hot wire perceptibly. So the method was proposed to the company as worth trying. It was tried, and proved to be a complete success. The sound ranging of the British armies was based upon it, with results which have already been described and are fairly well known.

It is clear that the all-important suggestion could only have been made by a man who had had scientific training and experience. That is one point of significance. The second is that it could only have been made by such a man actually on the spot. He could not have realised the details of the problem if he had been anywhere else.

It is worth while to consider this last point a little more closely. What precisely was the difficulty which could only

be resolved by a combination of knowledge and of being on the spot? It was really the difficulty of making a true estimation of quantities. It was a question of magnitudes and measurements. Anyone possessed of scientific knowledge could have said, if asked, that a gun must make an air pulse, and that an air pulse would chill a hot wire to an extent which might or might not be measurable. But there is all the difference in the world between such vague general knowledge on the one hand, and, on the other, the realisation that such a method is likely to work and give the desired result. It is the difference which so often escapes attention, but everyone of experience knows that it is to be reckoned among the essentials. It is so easy to talk generalities or to think of them, and so difficult to get down to the details which make the effort a success. It may be the last little adjustment of magnitude that turns the scale, and the last step the one that counts.

Are we, then, in this country, putting our scientific knowledge into the position where it is really effective? I would draw your attention to a most interesting and important movement which is attaining a notable magnitude.

A new class of worker is growing up amongst us consisting of the men engaged in research associations and industrial research laboratories throughout the country. We must place a high value of their services, for they are actually and personally bringing back with them into craftsmanship the scientific knowledge which is one of its essentials. They bring the interest and the outlook of scientific inquiry into touch with both employer and employed, and I cannot but think that they may be to some extent the flux that will make them run together. For they can speak with the employer as men also trained in University and College, exchanging thought with ease and accuracy. And, at the same time, they are fellow workers with those in the shops and can bring back there some of the interest and enthusiasm which springs from the understanding of purposes and methods. It is to be remembered always that personal contact has, on the whole, thanks to the better qualities in human nature, a marvellous effect in smoothing out differences. I do not think it is unduly optimistic to welcome the growth of this new type of industrial worker because it can, being in personal intercourse with both capital and labour, supply to each a new outlook on their whole enterprise, especially as that outlook is naturally illuminating and suggestive. For, after all, this is but going back to first conditions. The primitive craftsman has been replaced by separate persons or groups of persons who have slipped away from each other almost without our realising the fact. In the most recent times the separation has become more obvious and more dangerous, and that is why in so many directions efforts are being made to stem it. Can it be good that the workman has a part demanding little intelligence merely the capacity to repeat? Can it be expedient that mere manipulation should be left in the shop, while design and imagination have gone into the drawing office and shut the door behind them? Can it be right that the factory directorate should not be in immediate contact with the vast body of scientific knowledge?

The present number of industrial research workers is relatively small; it seems likely to increase, however, in proportion to the extent to which the province of science is better understood. The better understanding I think of as manifesting in the first place in industry itself. I am sure that here it is happily on the increase. There is also a broader view to be taken. There is a public estimation of the value of any calling which affects the numbers and the quality of those who respond.

I doubt if there is in the first place sufficient appreciation of the interests and rewards in the life of a student of industrial research. The pioneers have suffered unnecessary restrictions and discouragements, but their followers will be in better case. Surely it does not need much imagination to realise the splendid side of such work? The succession of fresh difficulties to be overcome, and of new and interesting views into the nature of things and ways of the world; the unforeseen value of results, sometimes an immediate prize, sometimes the clearing of an obstacle in a manufacturing process, never less than the discovery of facts which may some day be of use; the personal association with a living enterprise and with the human spirit behind it. And when it is realised that this kind of work is wanted badly, that it is really serviceable to the community, that there is opportunity for devotion, that it is in touch at once with human needs and with the furthest stretches of thought and imagination, it surely takes on to us the final touch of nobility.

We must remember also that the road of the student of science is still none too clear. The very methods of teaching science are a constant subject of discussion. I will say no more now than this: that the best

methods must take time to elaborate, and cannot be expected to have arrived at their final form. The difficulty is increased by the fact that science itself grows rapidly, and the extent of its application is only now revealing itself. That the knowledge of the immensity of nature and the study of the natural laws have an educative value is well recognised. That science can be used as an educational drill is also known and made use of. But there still remains the human side; the continuous effect of the growth of knowledge upon thought and enterprise; the realisation of the immense part that science is playing in modern life and is likely to go on playing. Education by scientific instruction is still apt to lack the comprehension of the human side, without which the classroom is a dull place.

There are even some who think that science is inhuman. They speak or write as if students of modern science would destroy reverence and faith. I do not know how that can be said of the student who stands daily in the presence of what seems to him to be infinite. Let us look at this point a little more closely.

The growth of knowledge never makes an old craft seem poor and negligible. On the contrary it often happens that under new light it grows in our interest and respect. Science lives on experiment; and if a tool or a process has gradually taken shape from the experience of centuries, science seizes on the results as those of an experiment of special value. She is not so foolish as to throw away that in which the slowly gathered wisdom of ages is stored. In this she is a conservative of conservatives.

What is true of a tool or process is true also of those formulæ in which growing science has tried to describe her discoveries. A new discovery seems at first sight to make an old hypothesis or definition become obsolete. The words cannot be stretched to cover a wider meaning. By no means, however, is that which is old to be thrown away; it has been the best possible attempt to express what was understood at the time when it was formed. The new is to be preferred for its better ability to contain the results of a wider experience. But in its time it will also be put aside. It is by a series of successive steps that we approach the truth: each step reached with the help of that which preceded it.

Nothing in the progress of science, and more particularly of modern science, is so impressive as the growing appreciation of the immensity of what awaits discovery, and the contrasted feebleness of our ability to put into words even so much as we already dimly apprehend. Let me take an example from the world of the physical sciences. There is a problem of which the minds of physicists have been full in recent years. The nineteenth-century theory of radiation asks us to look on light as a series of waves in an all-pervading ether. The theory has been marvellously successful, and the great advances of nineteenth-century physics were largely based upon it. It can satisfy the fundamental test of all theories, for it can predict the occurrence of effects which can be tested by experiment and found to be correct. There is no question of its truth in the ordinary sense.

In the last twenty or thirty years a vast new field of optical research has been opened up, and among the curious things we have found is the fact that light has the properties of a stream of very minute particles. Only on that hypothesis can many experimental facts be explained. A wave theory is of no use in the newer field. How are the two views to be reconciled? How can anything be at once a wave and a particle? I do not believe that I am unjust to any existing thinker if I say that no one yet has bridged the gap. Some of you who were present at the Liverpool meeting may remember that Bohr—one of the leading physicists of the world—doubted if the human mind was yet sufficiently developed to the stage in which it would be able to grasp the whole explanation. It may be a step forward to say, as we have been saying vaguely for some years, that both theories are true, that there are corpuscles and there are waves and that the former are actually responsible for the transference of energy in light and heat, and for making us see; while the latter guide the former on their way. This is going back to Newton, who expressed ideas of this kind in his 'Opticks,' though he was careful to add that they were no more than a suggestion.

We are here face to face with a strange problem. We know that there must be a reconcilement of our contradictory experiments; it is surely our conceptions of the truth which are at fault, though each conception seems valid and proved. There must be a truth which is greater than any o four descriptions of it. Here is an actual case where the human mind is brought face to face with its own defects. What can we do? What do we do? As physicists we use either hypothesis according to the range of experiences that we wish to consider. To repeat a phrase which I employed a few years ago in addressing a University audi-

ence familiar with lecture time-tables, on Mondays, Wednesdays, and Fridays we adopt the one hypothesis, on Tuesdays, Thursdays and Saturdays the other. We know that we cannot be seeing clearly and fully in either case, but are perfectly content to work and wait for the complete understanding.

And when we look back over the two centuries or so during which scientific men have tried systematically to solve the riddle of light, or even go further back to the surmisings of philosophers of still older time, we see that every conscientious attempt has made some approach to the goal. The theories of one time are supplanted by those of a succeeding time, and those again yield to something more like the first. But it is no idle series of changes, no vagaries of whimsical fashion; it is growth. The older never becomes invalid, and the new respects the old because that is the case.

Surely it is the same in regard to less material affairs. The scientific worker is the last man in the world to throw away hastily an old faith or convention or to think that discovery must bring contempt on tradition.

There is a curious parallelism here to a relation between science and industry of which I have already spoken. Just as any particular case of mass production can be regarded as a temporary condition which the growth of knowledge brings about, and in the end supersedes ,so also it may be said of any law or rule or convention or definition that knowledge is both the parent and eventually the destroyer. Time devours his own children. Even if a statement retains its outward form, its contents change with the meanings attached to its terms : and change moreover in different directions when used by different people, so that constant re-definition is necessary. How much more is this the case when the contents themselves have to be added to. The distinction between truth itself and attempts to embody it in words is so constantly forced upon the student of science as to give his statements on all matters a characteristic form and expression. And this is, I think, one of the reasons why men are often needlessly alarmed by the new announcements of science and think they are subversive of that which has been proved by time.

To this consideration I may add yet one more, which may be illustrated by the same analogy. Scientific research in the laboratory is based on simple relations between cause and effect in the natural world. These have at times been adopted, many of us would say wrongly, as the main principle of a mechanistic theory of the universe. That relation holds in our experimental work; and as long as it does so we avail ourselves of it, necessarily and with right. But just as in the case of research into the properties of radiation we use a corpuscular theory or a wave theory according to the needs of the moment, the two theories being actually incompatible to our minds in their present development, so the use of a mechanistic theory in the laboratory does not imply that it represents all that the human mind can use or grasp on other occasions, in present or in future times.

The proper employment of scientific research is so necessary to our welfare that we cannot afford to allow misconceptions to hinder it; and the worst of all are those which would suppose it to contradict the highest aims. Science, as a young friend said to me not long ago, is not setting forth to destroy the soul of the nation, but to keep body and soul together.

And some perhaps might say that in considering science in relation to craftsmanship I am pressing the less noble view; that I am not considering knowledge as its own end. It is said that uselessness in science is a virtue. The accusation is a little obscure because it may justly be said that knowledge is never useless. If I have thought of science in relation to craftsmanship it is because I have tried to set out the vast importance of what craftsmanship means and stands for. I have not forgotten that there are other aspects of the inquiry into the truths of Nature. Indeed, I could not carry out the lesser task without considering the whole meaning of science. And no clear line can be drawn between pure science and applied science : they are but two stages of development, two phases which melt into one another, and either loses virtue if dissociated from the other. The dual relation is common to many human activities and has been expressed in many ways. Long ago it was said in terms which in their comprehensiveness include all the aspirations of the searcher after knowledge : 'Thou shalt love the Lord thy God with all thy heart, and with all thy soul and with all thy strength '; and 'Thou shalt love thy neighbour as thyself.' In the old story every listener, from whatever country he came, Partians and Medes, Cretans and Arabians, heard the message in his own tongue. A great saying speaks to every man in the language which he understands. To the student of science the words mean that he is to put his whole heart into his work,

believing that in some way which he cannot fully comprehend it is all worth while, and that every straining to understand his surroundings is right and good; and, further, that in that way he can learn to be of use to his fellowmen.

SECTION B.—CHEMISTRY.

Phosphorescence, Fluorescence and Chemical Reaction.

ADDRESS BY
PROF. E. C. C. BALY, C.B.E., M.Sc., F.R.S.
PRESIDENT OF THE SECTION.

(*Continued from Page 168.*)

Now Lenard and Klatt established the very important fact that phosphorescent emission is not a truly reversible process. It is not in any way possible to activate a phosphore by exposing it to radiation of the same frequency as that which it emits when it has been activated. It is only possible to activate a phosphore by means of radiant energy on the same frequency as that of its characteristic absorption band which lies on the short wave-length side of the characteristic emission band. In short, these investigators proved the complete validity of Stokes' law, and as the result of later work on true phosphorescence this law has been proved invariably to hold.

The importance of this may at once be recognised if the facts be stated in more scientific phraseology. When an activated phosphore is emitting its characteristic luminescence each activated molecule radiates a single quantum of energy in passing from the higher energy state to the lower energy state, the total luminescence being the *sum of all these radiated quanta*. In the process of activation the change from the lower to the higher state is caused by the absorption of that same quantity of energy by each molecule, and in view of the radiation as a single quantum it is legitimate to assume that it is absorbed as a single quantum, nothing being expressed or implied as to the mechanism of the absorption. Each molecule, therefore, requires for its activation a critical quantum, nothing being expressed or implied as to the mechanism of the absorption. Each molecule, therefore, requires for its activation a critical quantum of energy $h\nu_1$, and the value of ν_1 may be directly obtained from the measurement of the luminescence. The proof given by Lenard and Klatt and by others that Stokes' law is valid indicates that it is impossible to activate a phosphore by means of radiant energy of the frequency ν_1, and that the critical quantum of activation cannot be supplied to a molecule by a singular absorption process. There exists, therefore, in this respect a sharp differentiation between the physical properties of molecules and atoms.

The lethal dose of criticism which killed the radiation hypothesis was based on the experimental proof that molecules are not able to do this very same thing, namely, absorb their critical quanta of activation $h\nu_1$ at the calculated frequency ν_1. The radiation hypothesis was killed because the assumption of the second part was made in ignorance of what molecules can do and cannot do.

It may be argued that the activated molecular states which are responsible for phosphorescence must be essentially different from those which function in chemical reaction, because their life periods are enormous compared with those of chemical processes. The fact, however, remains that in a series of different energy levels the uplift from a lower to a higher level cannot be achieved by the absorption of radiant energy of the frequency corresponding to the energy *difference*. The *stability of the* activated states in the field of phosphorescence and its remarkable variation with temperature are matters of great importance, but too much stress need not be laid upon them at this stage of the argument. A possible explanation will be given later.

It may be pointed out that there is a close similarity between the effective methods of activation in the fields of photoluminescence and photochemistry. In each the activation is achieved by exposing the inactive molecules to radiant energy of a frequency equal to that of a characteristic absorption band of the inactive state, and this frequency is invariably greater than that calculated from the quantum of activation. Stokes' law, therefore, may be said to apply to photochemistry as well as to photoluminescence.

In view of the mechanism of activation which is common to photoluminescence and photochemistry, it is legitimate to inquire into the destination of the excess of the energy absorbed over the critical quantum of activation. The energy quantum absorbed by a single molecule may be denoted by $h\nu_0$ and the critical quantum of activation by $h\nu_1$, where ν_0 is greater than ν_1, and the question is what happens to the energy difference expressed by $h\nu_0 - h\nu_1$. In the case of photoluminescence there is no doubt of the value of $h\nu_1$, since this may be calculated from the observed emission band, and

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$h\nu_0$ is also known from measurements of the absorption band or activating frequency.

It must be remembered that the one essential criterion for fluorescence is the existence with a finite stability of an energy level intermediate between the initial level and the super-activated level to which the molecule is raised by absorbing the quantum $h\nu_0$. It is by no means necessary that the stability of the intermediate level be sufficiently great for delayed or phosphorescent emission to be visible when the molecule changes from this level to its normal level. The conditions for phosphorescence are far more restricted and rigid, one of these being that the phosphore must be in the solid state. It is, therefore, not surprising that fluorescence is of far more frequent occurrence than phosphorescence.

Attention has already been directed to the close similarity between the activation processes in photoluminescence and in photochemistry. The principle of fluorescence radiation must also apply to photochemical reactions, in all of which the activating quantum is greater than the actual energy of activation.

Here, again, therefore, the relation should hold that

$$h\nu_0 = h\nu_1 + h\nu_2,$$

where $h\nu_0$ is the quantum of energy absorbed at the characteristic molecular frequency in the ultra-violet, $h\nu_1$ is the critical increment and ν_2 is the frequency of the fluorescence. It would seem, therefore, that the suggested explanation of fluorescence may be put to a very severe test by the quantitative study of photochemical reactions. Some preliminary observations have been carried out at Liverpool by Mr. Leathwood and these give definite support. The examples selected were not chosen from known photochemical reactions; rather was it considered desirable to determine whether photochemical reactions take place under conditions when fluorescence is visible and do not take place when fluorescence is not visible. Gas reactions have not been investigated owing to the difficulty of observation of the fluorescence of gaseous systems.

The theory of fluorescence now advanced may be considered as being a reasonable one, but it is advisable, before the main argument is pursued further, to examine it in more detail. In the first place the question may be asked as to the course of events when phosphorescence is absent and no chemical reaction takes place. All that the theory states is that any molecule on exposure to radiant energy of its characteristic frequency ν in the visible or ultra-violet region absorbs a single quantum $h\nu_0$ and is raised to a high energy level which has a very short life period. This super-activated state tends to return to its initial state with the radiation of energy numerically equal to $h\nu_0$. Under conditions not yet defined there can exist an intermediate level with a finite stability, and then the molecule falls from the high level to this intermediate level, and in so doing radiates the energy difference between these two levels as a single quantum of fluorescence. The intermediate level may be sufficiently stabilised by the conditions to exhibit the phenomenon of phosphorescence when the final fall to the initial level takes place, or, alternatively, the intermediate level may have a very short life period and may be recognised by virtue of its chemical reactivity. If this intermediate level does not exist, then neither fluorescence nor phosphorescence will be exhibited, and since optical resonance is unknown with compound molecules, the energy numerically equal to $h\nu_0$ is radiated in the infra-red. If the intermediate level exists, then fluorescence will be exhibited as the molecules fall to that level from the high level first produced. If the molecule when in the intermediate level undergoes no chemical reaction, the critical increment of activation of the intermediate level will also be radiated when the molecule finally reaches the initial level. It may be noted that in all cases of gases and liquids, where phosphorescence never occurs, the difference between the frequencies of the activating and fluorescence radiations is small. The critical quantum of activation, which is the difference between the absorbed and fluorescence quanta corresponds to a frequency in the infra-red.

As already stated, the theory involves the view that the activated states responsible for phosphorescence are similar to those which enter into chemical reaction, and it might be argued that they must be of markedly different type, since the life-periods of the former may be very long, whilst those of the latter are known to be very short. Such an argument, however, is based on the assumption that it is not possible to vary the life-periods of these intermediate states of activation by change of conditions. There is no justification for this assumption; and indeed the evidence is against it, since remarkable variations in the life-period can be produced by change of temperature alone. For example, Lenard and Klatt showed that by raising the temperature the life-period of the activated state in a phosphore could be

reduced from days or hours down to an exceedingly small fraction of a second. Then again von Kowalski showed that many substances in alcoholic solution, which only exhibit fluoresceuce at room temperatures, develop marked phosphorescence when cooled in liquid air.

Attention may be directed once again to the absorption spectra observations, and in particular it may be noted that the critical increment of the sulphonation reaction $h\nu_1$, is given by the product of the Planck constant iuto the difference between the central frequencies of the absorption bands shown by the anisole in solution in alcohol and in strong sulphuric acid. This follows at once from the fact that the fluorescence quantum of the anisole in alcoholic solution is equal to the quantum absorbed by the anisole in sulphuric acid solution. The conclusion would seem to be obvious that the absorption band of the anisole iu sulphuric acid solution is that characteristic of the activated state which in some way has been stabilised by the sulphuric acid. The stabilisation is proved by the fact that no measurable sulphonation takes place when the solution is allowed to remain at ordinary temperatures. At 50°, however, the sulphonation takes place with measurable velocity.

Two points of interest may be mentioned which arise from this. In the first place it would seem that the raising of a molecule from a lower to a higher energy level is accompanied by a shift in the characteristic absorption baud in the visible or ultraviolet region towards the longer wavelengths. This also occurs when phosphores are activated, for the absorption bands of the inactive materials lie in the ultra-violet, and those of the activated substances lie in the visible region.

In the second place it follows that the same super-activated state is produced when the inactive molecule absorbs the quantum $h\nu_0$ at its characteristic frequency, and when the chemically reactive molecule absorbs the quantum $h\nu_2$ at its characteristic frequency. In this way a possible connection with the radiation hypothesis is indicated. W. C. McC. Lewis developed a relation whereby the observed heat of a reaction may be calculated from the critical increments of activation. As stated previously he obtained the expression

$$d \log k/RT = Nh\nu_x/RT^2$$

where $h\nu_x$ is the critical increment of activation and k is the velocity constant. If the reaction be monomolecular and reversible then

$$d \log k^1/RT = Nh\nu_y/RT^2$$

where $h\nu_y$ is the critical increment of the resultant of the forward reaction and k^1 is the velocity constant of the reverse reaction. It follows that

$$d \log K/dT = Nh(\nu_x - \nu_y)/RT^2$$

where K is the equilibrium constant. Comparing the last expression with the van't Hoff isochore

$$d \log K/dT = -Q_v/RT^2,$$

Lewis concluded that the heat absorbed per stoichiometric quantity of the reactant transformed is given by

$$-Q_v = Nh(\nu_x - \nu_y),$$

that is to say, the heat involved in the reaction is equal to the critical increment of the resultant *minus* the critical increment of the reactant.

In this argument there is involved the view that in a reversible monomolecular reaction the activated reactant and activated resultant molecules are indistinguishable from one another. Applying this to a monomolecular photochemical reaction which is reversible it follows from what has gone before that the photochemical quanta may be substituted for the critical increments in Lewis' expression. The observed heat of the reaction will be given by

$$Q_v = Nh(\nu_r - \nu_0)$$

where ν_r and ν_0 are the characteristic ultraviolet frequencies of the resultant and reactant molecules, respectively. A near approximation to a monomolecular photochemical reaction is afforded by the conversion of oxygen into ozone, which is reversible. The central wave-lengths of the characteristic ultra-violet absorption bands of these two substances are very near to $185\mu\mu$ and $250\mu\mu$, respectively, the correrponding frequencies being $\nu_0 = 1.622 \times 10^{15}$ and $\nu_r = 1.2 \times 10^{15}$. The observed heat of reaction will be

$-Nh \times 4.22 \times 10^{14}$ ergs or $-36{,}400$ calories. This is very near to the accepted heat of formation of ozone.

(*To be Continued.*)

NEW ADVANCE IN THE WOOD PULP INDUSTRY.

THE "RINMAN" PROCESS.

By A WELL-KNOWN ENGINEER.

Obviously one of the most important industries to-day is the manufacture of wood pulp, not only as regards paper but also artificial silk, and an important advance has now been made in the soda process, that is boiling the rasped raw wood under pressure with caustic soda solution. As a result the ligno-celluloses of the wood are broken down and dissolved, leaving a pulp of unchanged

cellulose almost as pure as that obtained from expensive cotton or linen rags, and available for making into paper or other products on exactly the same lines. Hitherto, however, this process, which is ideal for "Kraft" paper for example without the use of sodium sulphide, has not been a success because of the difficulties of recovering the caustic soda. Now, however, after nearly twenty years' work, a process has been developed, and is in successful commercial operation, by Dr. Erik L. Rinman, a Swedish chemist, which is undoubtedly a revolution in the wood pulp industry, both utilising all the ligno-cellulose products in the liquor, known as "Black Lye," and recovering the caustic soda. The lye is evaporated down to a treacle-like product in vacuum evaporators and carbonised under low temperature conditions at not exceeding 750° F. The result is to give a whole series of valuable by-products, including methyl alcohol, acetone, methylethylketone, acetone oil, higher oils, heavy oils, and in many cases turpentine, somewhat similar to the carbonisation of raw wood. There is left a solid residue known as "soda coal," consisting of the mineral salts, practically all sodium carbonate, and free carbon, which is burnt on special new grates under steam boilers to consume the carbon, giving in this respect over 97 per cent. efficiency. The almost pure mineral residue is then extracted with water and converted into caustic soda again by boiling with lime, so that a wood pulp mill operating on these lines turns out not only pulp as usual, with caustic soda recovery, but in additiou a whole series of chemicals, with a great increase in revenue.

At the present time a large plant with an output of 600 tons of pulp a month, now being enlarged to 2,000 tons, is operating under the superintendence of Dr. Rinman at Regensburg in Bavaria, a well-known forest area, with ample water supply from the Danube. Also a powerful financial group in Great Britain has now been formed, in associating with the original company, Aktiebolaget Cellulosa of Stockholm, to develop the process throughout the word, while a mill is to be equipped immediately in Great Britain.

The "Rinman" process is equally applicable to the utilisation of all kinds of vegetable products, such as flax, hemp, manilla, esparto, bamboo, china grass, and straw, and a typical yield with, say, 5,000 tons of Kraft pulp is 125 tons of methyl alcohol, 90 tons of acetone, 90 tons methylethylketone, 60 tons acetone oil, 40 tons light oils, and 250 tons heavy oils.

CHEMICAL STUDIES OF SYNTHETIC GALENA AS A RADIO DETECTOR. V. DIRECTION OF THE RECTIFIED CURRENT.

By Wakasaburo Ogawa.

(Abstracted from the Journal of the Society of Chemical Industry, Japan.)

Though neglected hitherto by almost all the investigators, an important thing in the crystal detector is the composition and properties of the metallic needle to be used in contact with a crystal. It has been frequently mentioned that the needle point must not be oxidised and such a noble metal as platinum or silver has been recommended as a needle suitable for any crystal. But according to the author's experiments, the above statements hold good only with zincite crystal but not with galena. The needles of noble metals such as platinum, gold or silver give a poorer sensitivity with synthetic galena than more electropositive metals such as zinc, aluminium, magnesium. With synthetic galena a sharper point of metallic needles gives a better sensitivity, whilst with zincite it is not necessarily so.

In these experiments, the metals were used as a needle point and all of them exhibited some rectifying action with galena though there observed more or less difference in sensitivity. But when the contact area was increased as in a contact between a metallic plate and a flat surface of a synthetic galena crystal, only aluminium and magnesium were found to have a rectifying action.

In another series of experiments, a sharp point of a synthetic galena crystal was placed in loose contact upon the surface of metallic plates. With natural sharp points of argentiferous galenas, a silver plate gave a poorer sensitivity than a copper or aluminium plate. But with natural sharp points of argentiferous galena made by grinding with emery paper, all metallic plates gave only a very feeble sensitivity. It is very interesting to see that the direction of rectified current in the case of artificial point is opposite to the direction in the ordinary case.

To make clear the relation between sensitivity and the composition of metallic needle, the D.C. characteristic curves were plotted and it was concluded the superiority of sensitivity with such needles as aluminium or magnesium compared with platinum needle was partly due to the increase of current in the rectifying direction, and this in turn to an intrinsic nature of these needles.

If the direction of rectified current is defined to be positive when the current flows through the contact point from a metallic

needle to a crystal surface, all the synthetic galena which contains silver was found to give negative current. But the crystals of natural galena and those of simple synthetic galena consisting of lead and sulphur only comprise both negative and positive. The crystals activated by impregnating with various metallic salts also contain both varieties. A nothworthy fact was that almost all the crystals having good sensitivity in the galena group had negative sign. Some salts such as those of thoriub, arsenic, antimony and alkaline halides were found to have an activating effect though not remarkable in positive direction.

With respect to the direction of rectified current an interesting experiment was carried out as follows. As already stated, when a point of a synthetic galena crystal with 7.5 per cent. silver was sharpened by abrasion and lightly touched on the surface of metallic plates, using aluminium, copper, silver, lead, nickel and brass, the sensitivity was found to be quite feeble and the direction to be opposite to that in normal condition in all cases. A similar effect was observed when the surface of the crystal was polished flat by emery papers and tested with a needle point. The results were various after the varieties of the crystals and the roughness of the abrasives. Also it was observed that the reversion of rectifying direction in this experiment was temporary in most cases.

The directions of currents rectified by various couples composed of different crystals were determined and the following series was obtained, of which, if any two crystals are coupled, the rectified current will flow from the former to the latter: Argentiferous Galena-Corborundum A-Silicon - Tellurium - Nickel - Bornite - Chalcopyrite - Iron pyrite - Carborundum B - Zincite.

The following conclusions may be derived from the results of the preceding experiments.

The direction of rectification is principally determined by the chemical compositions of the substances which constitute the contact portions of both electrodes and is of a relative nature as the Voltaic phenomenon. It is modified not only by a small amount of impurities but also by a physical change of surface which has slight effect on the direction of thermo-electromotive force.

Though the rectifying action is affected by the degree of contact as already stated the most predetermining factor for the rectification is the intrinsic nature of the substance itself. If the tendency of this nature is expressed by a similar denotation as in the Voltaic series, zincite is the most positive crystal and has a similar nature with such a positive metal as aluminium. Argentiferous synthetic galena is the most negative crystal in the series and is more negative than the noble metals. Tellurium, bornite and chalcopyrite appear to be very close in their natures to the common metals such as nickel or copper.

Proceedings and Notices of Societies

THE INSTITUTE OF METALS.

ANNUAL AUTUMN MEETING, LIVERPOOL.
September 5 & 6.

The Copper-Magnesium Alloys. By W. R. D. JONES, M.Sc.

This paper dealt with notched-bar impact tests on forged and heat-treated copper-magnesium alloys. Further evidence has been obtained to show that there is no advantage in adding more than about 2 per cent. of copper to magnesium. Alloys containing more than 5 per cent. are brittle. The embrittling effect is decreased as the temperature rises. On exposure to cold, the toughness of these alloys has been decreased. Simple heat-treatment does not improve the notched-bar impact values to any appreciable extent.

The effect of forging on the microstructure has been to break down the eutectic network, resulting in an improvement of mechanical properties. Heat-treatment has merely increased slightly the size of the blogules of Mg_2Cu and the crystal grains, which are rendered equiaxed and more regular in size.

The Rockwell Hardness Test. By J. E. MALAM.

The paper described work carried out in order to furnish data for conversion between (a) Rockwell and Brinell and (b) Rockwell and scleroscope numbers for copper, 95.5, 70 : 30, and 63 : 37 copper-zinc, and 80 : 20 cupro-nickel.

An examination of these data leads to the conclusion that the Rockwell ball test in its present form yields so-called "hardness numbers" which must be considered as quantitatively misleading. Similarly it is found that unscientific results are obtained owing to the arbitrary numbering of the scleroscope scale.

There is an increasing use of methods of testing which yield results having no

rational quantitative significance. It is suggested that a representative committee be set up in order to consider the whole subject of hardness testing.

Die-Casting of Copper-Rich Alloys. By R. GENDERS, M.B.E., M.Met., F.I.C., R. C. READER, Ph.D., M.Sc., AND V. T. S. FOSTER, B.Met.

Results of some sections of a general investigation of the die-casting of copper-rich alloys were given. Exploratory examination of a wide range of alloys in the form of chill-cast bars and die cast test-pieces has indicated that a variety of alloys exists, suitable for die-casting and offering mechanical properties to meet varying requirements. The aluminium brasses, which were examined in greater detail, have advantages in their range of properties, high proof stress, slow rate of attack on mould and core materials, and cheapness. Mould and core materials were tested by immersion in molten alloys, both at rest and in continuous motion. High-carbon steel and special steels of the heat-resisting type showed little deterioration under the conditions of the tests, while low-carbon steel and engineering steels were rapidly attacked. The behaviour of cast iron in molten aluminium-bronze was largely influenced by the phosphorus content of the iron.

Properties and Production of Aluminium Diecastings. By S. L. ARCHBUTT, F.I.C., J. D. GROGAN, AND J. W. JENKIN, Ph.D.

The authors investigated (1) production and properties of aluminium alloy " die castings " made in permanent metal moulds under gravity feed, *i.e.*, without application of external pressure; (2) hot shortness of almuinium die casting alloys.

Five alloys have been employed in the study of die casting.

Two types of casting have been investigated (a) a shouldered test-piece of circular section suitable for testing direct without machining, (b) a hollow tubular casting requiring use of cores in moulding, and incorporating flanges and changes of section, features which cause difficulties in casting. Design and treatment of moulds, and conditions of working in respect to mould temperatures, pouring, stripping, etc., and the effect of the different alloy compositions on these are described together with the testing and properties of the castings obtained. To overcome defects due to air locks, shrinkage, stickng of cores, etc., very careful control of the working conditions was necessary including metal and mould temperatures, rate of pouring, interval between filling the mould and operations of drawing cores, opening the mould and stripping.

By means of a practised team of workers these operations were carried out with the degree of accuracy needed, and considerable success was thus obtained. Satisfactory castings were produced in the tubular form and from all the alloys studies. With the test-piece form castings of satisfactory mechanical strength were obtained in Y-alloy, 12 per cent. Si, and 3 per cent. Cu, 4 per cent Si, but less satisfactory results were obtained with the binary copper-aluminium alloys owing to hot-shortness.

In the investigation into hot-shortness the same five alloys have been studied together with L5 alloy (Cu 2.5-3.0, Zn 12.5-14.0 per cent.). The energy absorbed in fracture of an un-notched test bar cast to shape is taken as a measure of the hot-shortness. Some tests were made on freshly cast bars as they cooled down but the results mainly relate to bars re-heated to a steady temperature.

Hot shortness is only exhibited at temperatures close to the temperature of commencement of melting. Within narrow temperature ranges the impact strength falls rapidly from the maximum striking energy of the machine to zero or nearly so the commencement of melting. The range over which the rapid fall in impact strength takes place varies from 5° C. with the 12 per cent. Si alloy to 45° C. with L 5.

Die-Casting Alloys of Low Melting Point. By T. F. RUSSELL, Assoc.Met., W. E. GOODRICH, M.Met., W. CROSS, B.Sc., AND N. P. ALLEN, M.Met.

Sixteen zinc-base alloys, having either copper and tin, or copper and aluminium, and—in some cases—with further additions of either nickel, cadmium, lead, or magnesium, have been examined microscopically and thermally, and their densities determined. Pressure-cast flat test-pieces were made of each of the alloys and examined for tensile strength, hardness, bending, and for porosity, with special reference to the temperature of the mould, the size of gate influence of the casting temperature, the and vent, and the type of pull on the lever of the machine. The porosity depends almost entirely on the kind of pull on the lever, but the differences due to the kind of pull become less as the gate is opened. The copper-aluminium-zinc alloys are approximately twice as strong as the copper-tin-zinc alloys. For any one alloy, the casting conditions — within reasonable limits — have only a small effect on the tensile strength when compared with the influence of the

form of the test-piece, and of non-axial loading.

The effects on the strength and on the permanency of dimensions, after atmospheric ageing, have been investigated, and a very large number of tests of the so-called "accelerated ageing" type have been made. The "accelerated ageing" consists in subjecting the castings to the action of hot air, hot air saturated with moisture, and to steam at 100° C. The general conclusions are set out; the most important one being that, within the limits of the compositions examined, the effect of the chemical composition on the rate of growth is insignificant when compared with the effect of the form and mechanical condition of the actual casting.

Work on the action of molten zinc and of alloys on different ferrous materials was unfortunately left in an unfinished condition, and only the results of the action of molten zinc are given.

INSTITUTE OF CHEMISTRY.

Pedler Research Scholarship.

In June it was reported that the Council of the Institute of Chemistry had decided to utilise the income from the legacy bequeathed to the Institute by the late Sir Alexander Pedler, with accrued interest, now representing a sum of over £5,000, for the provision of a scholarship to be known as the Pedler Scholarship; that the Scholarship would be of the value of £250 per annum and would be open to Fellows and Associates of the Institute. It was decided that the Scholar should be required to undertake work on a problem or problems to be chosen by the Council and that, in selecting the problem, the Council would have regard to the need for its investigation in the public interest. Fellows and Associates were invited to suggest suitable problems for invesgation under this scheme, and the Pedler Fund Committee was requested to announce the problem and to invite applications from candidates for the Scholarship.

On a report from the Committee, the Council of the Institute has decided that the value of the Scholarship be increased to £300 per annum, and that applications be invited from candidates who are willing to work on one of the following subjects :—

(a) Study of the sterols of natural fats, with a view to their quantitative separation and diagnostic value.

(b) Determination of sugars of common occurrence in their mixtures, with special reference to foods.

(c) Methods for the determination of casein, albumin and globulin in milk, and consideration of any points arising therefrom.

Applications are accordingly invited from Fellows and Associates who desire to become candidates for the Scholarship, subject to such conditions as the Council may prescribe, including the following :—

The Pedler Scholar will not be permitted to hold any other Scholarship or Bursary, except with the knowledge and consent of the Council.

The award will be of the annual value of £300, as stated, payable monthly, and be tenable for one calendar year, but at the discretion of the Council may be extended for any further period at the same rate.

The work shall be conducted in a laboratory approved by the Council and under the general direction of any person or persons duly authorised by the Council for this purpose, who shall report to the Pedler Fund Committee from time to time as required.

The Council will defray the expenses of the research out of the Pedler Fund, all such expenses being subject to the approval of the Council or any officer duly authorised for this purpose.

The results of the investigations undertaken by the Scholar shall be the property of the Institute and shall be published as the Council may direct. Any such publication, however, shall be in the name of the Scholar solely.

Applications for the Scholarship should be addressed to the Registrar so that they be received at the offices of the Institute not later than Monday, the 24th September.

It is hoped that the candidate may be informed of his or her appointment before the 1st October, with a view to commencing work as soon as possible after that date.

CANADA'S MINERAL POSSIBILITIES.

The year 1928 is unparalleled in the history of Canada in the search for mineral deposits both for its intensiveness and for its breadth of activity. Never in any one year has so much money been spent in exploration as will be spent this year. The operations are Dominion-wide but by far the most important are those that are directed to areas underlain by the Pre-Cambrian rocks of the northern parts of the provinces of Quebec, Ontario and Manitoba, and the Northwest Territories.

The most spectacular explorations are those that are headed into the more remote parts of the country east and west of Hud-

son Bay. When it was learned last winter that transportation to Flin Flon was to be provided, that large ore-body was finally to be exploited, and that other large ore-bodies in northern Manitoba had been discovered, the Department of Mines at Ottawa was flooded with requests for information regarding that part of the country. Then interest broadened and the possibilities of more remote areas were considered. It was felt that the completion of the Hudson Bay Railway to Churchill and boat transportation on the bay would render accessible a great stretch of country that had hitherto been regarded as Canada's hinterland. Then came the desire to be on the ground early and secure the best. The result is that a great many prospecting parties have left for these northerly areas. The exploratory work is intrusted to hardy men of experience and knowledge. To see that these are properly equipped so that the element of risk is reduced to a minimum, men, some of whom are well past middle age, are entering the game with the zest of youth. They are full of enthusiasm and for some the thrill of the moment is in itself reward for the efforts put forth. Some prospectors have gone to Hudson Bay by way of Northern Ontario and Northern Manitoba, others have left by boats from points on the Atlantic coast. One company alone has sent by boat ten parties of two men each and the necessary supplies. These will be assisted and directed by men sent in by aeroplane.

In the more readily accessible areas and in areas where transportation facilities are of the best, search for more mineral deposits is being prosecuted with feverish intensity. This takes the form of surface prospecting and of underground testing by diamond drilling, shaft sinking, and drifting. All this exploratory work has been given a powerful impetus by the discoveries made in Northern Manitoba, the Rouyn area of Western Quebec, and the Sudbury, Patricia and other areas of Ontario, and it is expected that by the close of the year a very important addition will be made to the known and developed mineral reserves of the country.

PUMPS.

Board of Trade Announcement.

The Standing Committee (General Merchandise, Merchandise Marks Act, 1926), appointed by the Board of Trade have reported on their enquiry as to whether imported pumps of all descriptions should be required to bear an indication of origin.

The Reort is obtainable from the Stationery Office, or throught any bookseller, price 2d. a copy.

NOTICES OF BOOKS.

A BRAZILIAN TEXTBOOK OF CHEMISTRY.

Prof. Alvaro Soares Brandao has written a *Chimica* (*Curso Secondario*) for use in Brazilian High Schools and Colleges, which has been published by Melhoramentos de S. Paulo.

The author has, in the main, followed conventional textbook practice in first giving a series of general chapters dealing with the nature and principles of the science and its general development and classification. Then come a series of chapters describing the more important phenomena associated with physical chemistry, *e.g.*, the gas laws, chemical kinetics, colloidal phenomena, thermochemistry, affinity, etc.

The section on Inorganic Chemistry is divided into non-metals and metals, whilst the Organic Section deals with the more important homologues series of carbon compounds, with special emphasis upon such industrial products as alcohol and vinegar. Indeed an industrial bias is observable throughout the volume, which is illustrated by many woodcuts, etc., from manufacturing processes. The laboratory apparatus figured in the case of a number of preparations will seem a little quaint to English scientists, but it has the merit of being practical.

The periodic classification used by Prof. Brandao is out of date. No mention is made, for instance, of Moseley's work or of atomic numbers, and the equivalents given are not always in accordance with the accepted European figures, e.g., antimony, 120; aluminium, 13.75; boron, 11; nitrogen, 14; and phosphorus, 31.

Whilst North America has a very extensive chemical literature of its own the South and Latin America seems to be lacking in both journals and textbooks. One can only hope that British periodicals and scientific books are used and will continue to be read by both students and professors in Brazil and other parts.

J. G. F. D.

Volumetric Analysis. By A. W. Wellings, B.Sc. Pp. xii + 1926. London: Methuen & Co., 36, Essex Street. 1928. Price 5s.

This systematic text book of practical volumetric analysis is intended to meet the complete study from the elementary exercises on neutralisation right up to the University students' more advanced applications of volumetric methods. The usual

sets of experiments are included and much emphasis is laid upon Iodometry. The author claims that a very large number of estimations may be conducted by the use of the Iodine methods. He also includes an account of the theory of indicators in which the phenomena due to the hydrolysis of the electrolytes are considered from the standpoint of Ostwald's Dilution Theory.

The Chemistry of Plant Products. By P. HAAS, D.Sc., AND T. G. HILL, D.Sc. Fourth Edition. Pp. xvi + 530. London : Longmans, Green & Co. 1928. Price 18s.

This important volume on the nature and significance of the organic substances occurring in plant tissues has become a standard work on the borderline subject and has undoubtedly stimulated much of the biochemical investigations of the last few years. The results of these researches are included in the new edition which has consequently had to be re-written in numerous chapters, especially that dealing with the carbohydrates and enzymes.

Colloid Chemistry. By PROF. T. SVEDBERG. Second Edition. Pp. 302. New York Chemical Catalog Co. 1928. Price $5.50.

This authoritative work on a new and evergrowing subject has been thoroughly revised for the second edition which appears four years after the first was published. Additions have been made to give accounts of new technique, *e.g.*, the application of the X-ray methods of examining sols and gels. The latest devices in measuring diffusion and cataphoresis are given, together with the deductions to be drawn from the results.

The extensive bibliography also adds to the value of the second edition in the compiling of which the author has had the assistance of Dr. Arne Tiselius.

Forthcoming Events.

THE FARADAY SOCIETY.

A general discussion on " Homogeneous Catalysis " will be held at the University of Cambridge on September 28 and 29, chairman, Professor C. H. Desch, D.Sc., F.R.S.

PROGRAMME OF PAPERS.

Introductory Paper.—" Some Problems in Homogeneous Catalysis." By T. M. Lowry.

Part I. General Relations.

" Homogeneous Catalysis." By C. N. Hinshelwood.

" The Influence of Nitrogen Peroxide on the Union of Hydrogen and Oxygen. A Problem of ' Trace Catalysis.' " By C. H. Gibson and C. N. Hinshelwood.

" Catalytic Phenomena in the Tautomerism of certain α-Diketones." By Henri Moureu.

" Negative Catalysis." By E. K. Rideal.

" Ionisation in Chemical Change." By N. R. Dhar.

" Negative Catalysis in Slow and Induced Oxidations." By N. R. Dhar.

" Phosphorescence and Autocatalysis during Slow Combustion " By F. Gill, E. W. J. Mardles, and H. C. Tett.

" Negative Catalysis." By H. Baeckstroem.

Part II. Intermediate Addition-Compounds and Chain Reactions.

" Compound Formation in Ester-Water Systems." By James Kendall and Lilian E. Harrison.

" Report on the Theory of Chain Reactions." By J. A. Christiansen.

" Bromine Inhibition of Chain Reactions." By M. Polanyi.

" The Theory of Molecular Dislocation Applied to Homogeneous Catalysis." By J. Böeseken.

Part III. Neutral Salt and Activity Effects.

" The Theory of Acid and Basic Catalysis." By J. N. Brönsted.

" Catalytic Effects of Acids and Bases and the Influence of Inert Salts." By H. M. Dawson.

" Compounds between Catalysts and Substrates and their Reactivity." By H. von Euler.

" On the Catalytic Activity of Hydrogen Ions in Ethyl Alcohol." By H. Goldschmidt.

" Investigations of Salt Action in Homogeneous Catalysis." By H. S. Harned and G. Akerlöf.

" Keto-Enol Isomerism and the Mechanism of Homogeneous Reactions." By F. O. Rice and J. J. Sullivan.

" The Activity Theory of Reaction Velocity. The Rate of Interaction of a Chloroamine and Hydrobromic Acid." By F. G. Soper.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,168.—I. G. Farbenindustrie Akt.-Ges. —Production of sulphonic acids. September 1st.

24,948.—Nelson, A. C., and Richardson, R.—Apparatus for drying sulphate of ammonia, etc. August 30th.

24,987.—Pocock, A. L. — Producing metallic oxides in crystalline, etc. August 30th.

24,864.—Rees, R. Van.—Process for recovering camphor from camphor-containing substances. August 29th.

24,935.—Bucherer, H. T. — Methods of carrying out chemical reactions. August 30th.

Specifications Published.

296,121.—Ormandy, W. R.—Manufacture of nitric acid.

296,172.—Suida, Dr. H.—Recovering concentrated acetic acid from dilute acetic acid.

284,614.—Geigy Akt.-Ges., J. R.—Manufacture of acid dyestuffs of the pheno-naphthosafranine-series.

296,106.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of N-dihydro-1.2.1′.2′ anthraquinone-azine.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

VOLTITE.

492,758.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—British Dyestuffs Corporation, Limited, Hexagon House, Blackley, Manchester. September 5th.

PATENT LICENCES.

The Owners of Patent No. 222461 relating to

"APPARATUS FOR THE SYNTHETIC PRODUCTION OF AMMONIA AND ITS ELEMENTS,"

are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. LLOYD WISE & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

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INDIAN CIVILISATION.

It is often urged that too little is known in the west of the culture of ancient India. An imortant and interesting work on the subject from the pen of Dr. Bhudeb Mookerji entitled *Indian Civilisation, and Its Antiquity* (price 2 rupees)* is now available and deserves a wide circle of readers.

Dr. Bhudeb Mookerji is known to readers of *The Chemical News* as the author of *Rasa-Jala-Nidhi*, or Ocean of Indian Chemistry, of which two volumes of the projected ten bi-lingual texts have appeared (see *The Chemical News*, 1927, cxxxv, 190, Sept. 16; 1928, cxxxvi, 302, Jan. 13).

This distinguished Indian author has now devoted some attention to a subject which will command a wider range of readers. Scientists, and especially chemists, will be particularly interested in his long chapter on Indian Chemistry as well as in his appendix on Trismegistus, Paracelsus (whom he states probably visited India) and Robert Boyle.

Dr. Mookerji mentions in his preface that the universe has been in existence so long that it is impossible to go through all the records of even a short period, consequently early Indian compilers contented themselves with brief references to the outstanding facts of many years. Thus the Paranas are but records of kings, sages and events often thousands of years apart, and preserved chiefly because of their moral or religious value. These with the Vedas and Tantras are the most ancient Indian literature. The modern style of language indicates recent revision but does not necessarily mean that they are of late origin. From them Dr. Mookerji has ventured to explain phallism and the spread of Indian culture, the part played by Gypsies in this, the antiquity of Indian chemistry and English words of Sanskrit origin.

He concludes that the Indians of old travelled to Europe even in prehistoric times and that the movements of gypsies from the east (Bengal) to the west, before 1,000 B.C., conveyed ideas and information to the peoples with whom they came in contact. He credits Crete with being an Indian colony.

With reference to chemistry the author suggests that Mr. Stapleton's view that a knowledge of metals and minerals came to India from the west may not be correct for mercury and other metals and inorganic bodies were found at one time in India although in some cases (*e.g.*, mercury), the supply has been exhausted. As Mr. Stapleton has proved, a knowledge of organic chemistry had developed early in India and Dr. Mookerji now adduces evidence to show that the same was the case with inorganic chemistry and he differs from some of the views expressed by Sir P. C. Roy on this matter and on other points, notably on the identity of Govinda, the chemist who flourished in the 8th century.

Philologists will be interested in Dr. Mookerji's views on the origin of a number of words which is the subject of chapter 4 of the present work.

The mass of information that the author has collected and presented in a very readable form should do much to stimulate an interest in Indian culture and especially in its contributions to early science.

J. G. F. DRUCE.

* *Indian Civilisation.* By DR. BHUDEB MOOKERJI, M.A., 43a, Grey Street, Calcutta. Pp. xii +128. 1928. Price 2 rupees.

British Association for the Advancement of Science.

SECTION B.—CHEMISTRY.

Phosphorescence, Fluorescence and Chemical Reaction.

ADDRESS BY
PROF. E. C. C. BALY, C.B.E., M.Sc., F.R.S.
PRESIDENT OF THE SECTION.

(*Continued from Page* 185.)

It may be concluded from the foregoing that a definite position has been reached which is of some interest. The radiation hypothesis states that the first stage of a chemical reaction is the activation of each molecule of the reactant by the absorption of one quantum of energy, which has been called the critical quantum of activation. Evidence gained from the experimental investigation of the phenomena of photoluminescence gives strong support to the reality of this critical quantum of activation, but entirely disposes of the possibility of a molecule gaining this quantum by a single absorption process. The photochemical activation of molecules has been discussed in the light of the evidence gained from the fields of photoluminescence and absorption spectra and the destination of the whole of the energy gained by a molecule when it absorbs its photochemical quantum has been traced. Lastly, the connection between the observed heat of a reaction and the critical increments of activation, derived by the radiation hypothesis, has been extended to the photochemical quanta, which is an advantage, since the photochemical frequencies can be directly observed by spectroscopic methods. It may even be considered that the exhumation of the radiation hypothesis has been partly justified.

There is no doubt, however, that this partial justification raises the question of thermal reactions in a form which is even more acute than was the case at the inception of the radiation hypothesis. The inability of a molecule to gain its critical quantum of activation by means of a single absorption process has been demonstrated in a far wider field than was covered by the experiments of Lindemann and G. N. Lewis, which as a matter of fact were devised *ad hoc*. Unless some mechanism exists whereby a molecule can gain its critical quantum of activation from a source of infra-red radiation, photochemical activation must be viewed as an abnormal event and the exhumed radiation hypothesis must be reinterred at once and for all time. It is only fair to ask that the question of thermal reaction be approached and discussed entirely without prejudice, and this is all the more necessary because it has generally been felt that not a single hope remained for the hypothesis and men's thoughts have turned to activation by collision with a tendency to exclude any other possibility.

I have been led to re-open this question by some recent observations which appear to throw new light on the problem. These observations encourage me to suggest a possible mechanism of activation by infra-red radiation. Some justification may be found in the fact that it offers an explanation of many of the difficulties that have been met with in interpreting the phenomena observed in absorption spectra.

Mr. Hood at Liverpool has succeeded in determining the temperature coefficient of the reaction whereby carbohydrates are photosynthesised from carbonic acid in the presence of pure nickel carbonate. The experimental method consists in the irradiation of a suspension of the carbonate in pure water, maintained by a stream of carbon dioxide, by the light from an ordinary tungsten filament lamp. The yield of the carbohydrates at various temperatures between 5° and 40° has been determined with considerable accuracy. The investigation only became possible when a satisfactory method had been devised for the preparation of pure nickel carbonate. The method consists in the electrolysis of pure water, saturated with carbon dioxide, with nickel electrodes. The carbonate is collected, dried at 100°, and then heated at 140° for thirty minutes. It is then powdered and passed through a 100-mesh sieve, after which it is activated by irradiation with white light for 18 hours. The powder must be used very soon after it has been activated.

It has previously been shown that

1. Carbonic acid in aqueous solution is not acted on by white light.
2. Carbonic acid when adsorbed on a coloured surface does not react in the dark.
3. Carbonic acid when adsorbed on a coloured surface and irradiated by white light reacts to give carbohydrates.

It follows as a necessary conclusion from the facts that the complete activation of the

carbonic acid must take place in two stages, namely, partial activation by adsorption with the formation of a molecular state capable of absorbing some rays within the visible spectrum, whereby the activation is completed by photochemical means. Furthermore, the number of partially activated molecules which are able to enter into the final reaction is in linear proportion to the temperature. It is this first stage of partial activation which is of interest in our quest, since it is evident that the adsorption process alone is not sufficient to bring the molecules into a state which enables them to react photochemically under the influence of visible light, the supply of heat energy being necessary to add the finishing touch to the partial activation.

There is a striking analogy here with anisole and the other phenolic ethers and their nitro derivatives in solution in concentrated sulphuric acid which were referred to above. There can be no doubt that the ether molecules in the acid solution have gained their critical quanta of activation, and yet their activated states must be stabilised in some way, since no measurable sulphonation takes place at ordinary temperatures. When the solution is warmed at 50° the expected reaction proceeds. This stability of the activated states has placed great difficulty in the way of explaining many observations of absorption spectra.

Now it is very probable that there is one factor which is common to the two sets of observations, namely the existence of a complex, that is to say an adsorption complex of carbonic acid and nickel carbonate in the one and an addition complex or solvate of the ether and sulphuric acid in the other. If the mechanism of complex formation be considered it would appear that two methods are possible whereby a complex form a complex with a loss of energy, and such a complex will only be resolved into its components by the supply of energy equal to that lost in its formation. As an example of this type of complex the salt of an organic base such as aniline may be instanced, this type having a positive heat of formation.

On the other hand it may be suggested that another possibility exists, namely the formation of an addition complex of two components, one of which yields a definite amount of energy to the other. Such an energy transference, so far as external evidence is concerned, will be an isothermal process. It may further be suggested that the amount of energy given up by the first component to the second component is equal to the critical quantum of activation of the second component. Such complexes will not be formed between any two molecules, but only between two which satisfy the conditions, the criterion being that a molecule of one compound, possibly by loss of rotational energy, can give to the molecule of another compound, energy equal to the critical quantum of activation of that molecule. A complex of this type may be denoted by the symbol $A^{-}B^{+}$, where B has gained its critical quantum of activation at the expense of the rotational energy of A.

Let it be accepted that such complex formation is possible in order that the properties of these entitics and their probable influence on the phenomena under discussion may be critically examined. It may first be concluded that, even though the molecule B has become activated, the reaction characteristic of the activated state will not take place until the energy defect of the molecule A has been restored. In other words the activated state of the molecule B has become stabilised. In the second place the resolution of the complex into a normal molecule of A and an activated molecule of B will be secured by making good the defect in the rotational energy of the molecule A. The formation of a free molecule of B in the activated state is no longer a process of direct activation by radiant energy, which has proved to be impossible, but an increase in the rotational energy which, as is known, can be effected by means of infra-red radiation.

This hypothesis may in the first instance be applied to the phenolic ethers, all the relevant facts of which have already been stated. The quantitative relation between the absorption bands of these substances leaves little or no doubt that each ether in concentrated sulphuric acid solution has in some way gained its critical increment of activation, and in spite of that fact the ether does not undergo sulphonation at ordinary temperatures. It has always been very difficult to understand why this activated state is a stable one and why the reaction characteristic of that state does not take place unless the solution is warmed. The explanation is simple enough on the present hypothesis. The entity present in sulphuric acid solution is a complex or solvate of the ether and sulphuric acid, in which the ether molecules have gained their critical quanta of activation at the expense of the rotational energy of the sulphuric acid molecules. The reaction to give the sulphonic acid and water cannot take place within the complex, since the photochemical experiments prove that the reaction takes place between the

activated molecules of the ether and free sulphuric acid molecules. The complex molecule, therefore, will be stable below a certain temperature. On raising the temperature the defect in the rotational energy of the sulphuric acid molecules will be made good and the sulphonation will then take place.

The hypothesis also offers an explanation of the temperature coefficient of the photosynthesis of carbohydrates from carbonic acid, referred to above. In this case the complex is the adsorption complex of carbonic acid and nickel carbonate, in which the carbonic acid molecule has gained, at the expense of the rotational energy of the nickel carbonate molecule, its critical quantum of activation to the intermediate level. So long as the complex exists the carbonic acid will not undergo reaction when it is irradiated by white light, and in consequence no measurable reaction takes place at the lower temperatures, even though the carbonic acid molecule may be raised by the absorption of light to its higher energy level. When the temperature is raised the energy defect of the nickel carbonate is made good and the activated carbonic acid molecules are set free. Two alternatives exist as regards the final activation of the partially activated carbonic acid molecules by their absorbing light. Either the partially activated molecule gains its second increment of activation by absorption of the photochemical quantum when it exists in the complex, in which case the increase in temlerature will set free the fully activated molecule, or the second increment of activation is gained by the absorption of the photochemical quantum at the instant and partially activated molecule, or the second increment of activation is gained by the absorption of the photochemical quantum at the instant the partially activated molecule is set free by the rise in temperature. In either case the fully activated molecules react to give activated formalyehyde and oxygen, this being immediately followed by the polymerisation of the activated formaldehyde to give the hexoses. The evidence is strongly in favour of the first alternative, as will presently be explained.

When the temperature is progressively raised above the characteristic limit an increasing number of complexes will be resolved in unit time, and the reaction velocity will increase. It may be said, therefore, that the stability of the complexes progressively decreases as the temperature is raised above the temperature limit, and it follows that there must be an upper temperature limit above which the complex will have no measurable stability, and at this temperature the reaction velocity of a simple chemical reaction will reach a maximum and will indeed be instantaneous, if such a word can be applied to a process involving the mixing together of the reactants. The photosynthesis reaction is differentiated by the fact that it consists of two stages, and the temperature limits concern only the stability of the adsorption complex characteristic of the first stage.

The hypothesis of complex formation also offers an explanation of the phenomena of photoluminescence. There is one outstanding fact in connection with the activation of the phosphorogen in a phosphore which indicates the presence of a complex of the type we are dealing with. In all cases where the activating wave-lengths have been measured, these are longer than those which are characteristic of the phosphorogen in the free state. This at once leads to the view that each phosphorogen molecule has formed a complex with a molecule of the diluent, and within that complex the phosphorogen exists at a level of higher energy content than the normal. The stability of the complex will be determined by the tempearture as it can only be resolved into its components by the supply of infra-red radiation to make good the defect in the rotational energy of the diluent molecule. Even though the phosphorogen component is raised to a still higher level by absorption of its characteristic quantum at the ultra-violet frequency, the complex will remain in its stable state provided that the temperature is below the lower limit characteristic of the complex. An instance of an exactly analogous phenomenon is the very striking fluorescence of benzaldehyde in concentrated sulphuric acid solution. In this case the aldehyde within the complex absorbs and radiates energy without its stability being affected. It may therefore be suggested that even after the phosphorogen has been raise to a higher level of activation than that which it reaches in the actual formation of the complex, the new state is no less stable than the complex itself. If that be so the whole of the phenomena of photoluminescence which have been previously described will find a simple explanation. There will be a lower temperature limit below which the activated complex will be completely stable, that is to say, no phosphorescence will be observed. When the temperature is raised above the lower limit the region of partial stability will be entered and phosphorescent emission will

begin, and progressive rise of temperature will progressively increase the number of complexes that are resolved and the intensity of the phosphorescence will increase. Since there are present a finite number of complexes the total persistence of the emission will decrease. At any constant temperature between the lower and upper limits the intensity will have a definite rate of decay. Just below the upper temperature limit where the stability is vanishingly small the persistence will be vanishingly small and the intensity will be the maximum. Up to this stage the phenomena will be identical with those of a chemical reaction, the criterion of intensity of phosphorescence being substituted for the criterion of reaction velocity. When the upper temperature limit is passed the complex will no longer have any stability and will no longer exist. No phosphorescence or fluorescence will be possible, since these depend on the stable existence of the complex with its power of retaining the energy which it absorbs at its characteristic frequency in the ultra-violet. These phenomena are identical with those observed by Lenard and Klatt.

One fnrther piece of evidence, which has hitherto not been mentioned, may now be brought forward. The hypothesis of complete formation demands that the defect in the rotational energy of the 'catalyst' or diluent component may be absorbed as infra-red radiation. In all that has gone before this defect has been supplied by raising the temperature, and the hypothesis cannot be considered as entirely justified unless it be proved that resolution of the complexes can be achieved by exposure to infrared radiation. The fact that the most effective method of deactivating an activated phosphore and of releasing the whole of its phosphorescence is by exposing it to infrared radiation adds a conclusive argument in support of the hypothesis.

(To be Continued.)

SECTION G.

Abstract of Address of the President, Sir William Ellis, G.B.E., D.Eng.

The Anthor in his address deals with the interesting subject of the direct association during the latter part of the last century between Engineering and the amenities of modern life resulting from the great developments which have taken place in all branches of Engineering. He illustrates this fact by reference in considerable detail to the various branches of Civil Engineering, Transport, Mechanical Engineering and Electrical Engineering.

The address set out very clearly how dependent for its development civilisation is on each and all these branches of Engineering, illustrating how the segregation of large populations in industrial areas has rendered necessary for the comfort of their lives, an ample supply of reliable water and efficient drainage system, and how the progress of new countries depends on efficient transport by rail to enable the agricultural and mineral wealth to be transported.

The address gave interesting facts dealing with the wonderful developments in tonnage and horse-power of ocean going vessels and called attention to the safety and comfort of travelling to-day compared with 40 years ago.

The author pointed out that the various developments of electricity, the telegraph, the telephone, electrical driving, lighting, etc., have a large share in improving the domestic amenities of the general population and urged the greater use of electricity for both lighting and heating for reasons both of cleanliness and health.

The address contained an interesting reference to the introduction of the telephone by Professor Graham Bell at the British Association Meeting at Plymouth in 1877.

SECTION K.

Sex and Nutrition in the Fungi.

Abstract of Address of the President, Professor Dame Helen Gwynne-Vaughan.

There are probably between thirty and forty thousand species of fungi, a group which includes the moulds, mildews, rusts, toadstools, puff balls and a vast assemblage of microscopic forms. Many are parasites, causing diseases of crops and fruit trees, others obtain their food from plant and animal remains and are usefnl scavengers. They have in common a simple type of body, consisting of long, branched filaments; these may grow separately through the substratum, or may be woven into a comparatively solid structure, like a mushroom or a truffle. Sooner or latter spores are developed, usually on some of fructification; they are in many cases the product of a sexual process, though in some of the fungi the sexual apparatus is tending to disappear, and in whole groups no trace of it remains.

One of the groups which still shows sexual reproduction is the white moulds of bread (Mucorales). Here the sexual organs are large cells containing many nuclei. They fuse together, the nuclei pair, and a new generation is produced. As a rule these organs are quite similar in appearance and

behaviour, so that one cannot say which is *male and which is female. Nevertheless* they are borne on distinct plants, and will only develop when appropriate plants are brought into contact. To get over the difficulty of nomenclature the two kinds of plants are known as (+) and (-). This is sex at its simplest, we can only define a (-) individual as one which produces a new generation with a (+), and a (+) as one that does so with a (-).

In the toadstools and their allies (Hymenomycetes) the sexual apparatus has wholly disappeared, but, in many cases, before spores can be formed, fusion has to take place between the filaments of two independent plants. When this was first observed it was compared with the condition in the white moulds, the two kinds of plants were described, here also, as (+) and (-), and, in spite of the absence of sexual organs, *the difference was regarded as one of sex.* Things became more complex when fungi were observed in which there were three kinds of plants, any one being able to form a new generation with either of the others, or four kinds, the new generation depending on the association of an appropriate pair. Moreover, it was seen that suitable food would, in some cases ,enable a single individual to form spores by itself, and evidence was *brought forward that unions* between two (+) or two (-) strains were *sometimes fertile, if these were derived* from different stocks.

The President of Section K. had for some time been doubtful about the sexual significance imputed to these fusions, and had suggested that the difference between (+) and (-) strains in the toadstools might lie, not in their sex, but in their capacity to *accumulate the food materials necessary* for the formation of spores. It is difficult to envisage a race with four sexes, but a race requiring four or more food substances in preparation for the fruiting period is a matter of common experience. She was able to clinch her argument by reference to some work in progress in her laboratory at Birkbeck College. One of the cup fungi (Ascomycetes), a little, orange species, common in fields, had been grown in culture. It fruited readily enough when several spores were planted together, and the fruits were found to develop from the female organ, but without fertilisation. In spite of this, when a single spore was planted alone, the filements produced from it never gave rise to fructifications; when, however, branches from two appropriate spores were allowed to meet, a row of orange coloured fruits was the result. Here was another species, showing, like the toadstools, a (+) and a (-) strain, the co-operation of which was necessary for the new generation; but in this case the sexual apparatus had not wholly disappeared. The (+) and (-) filiments were examined; both were found to bear female organs, but these soon died if one kind of filament was grown by itself. The filament between them was evidently not one of sex; both sorts of filament were female, but apparently neither alone could obtain all the food needed for complete devedopment. The association was a partnership in catering, and its relation to other forms of nutrition and to primative sexuality, like that of the white moulds, were fully discussed.

THE CRUX OF THE QUESTION.

By Dr. W. Tombrock.

How is it nowadays that the physicist is up against contradictions which are unknown to the chemist in his branch of science? (See "Is Nature Contradictory?" *Chemical News*, cxxxvii, 113.)

Because the chemist occupies himself practically exclusively with the properties of matter perceptible to the senses, and the physicist tackles the ether as well. And how is it possible that the physicist in so doing arrives at contradictions, real, not apparent, contradictions? Contradictions, which presuppose impossibilities, which presuppose things which *cannot* exist in reality?

Because the physicist implicitly or explicitly attributes to the ether properties which the substance, even in its ultimate state of division, does not essentially possess.

Ether is the substrate of physics just as much as is matter perceptible to the senses.

Ether *must be able to move, if the ether* is to be the substrate of phenomena which presuppose motion. Ether is material, if we understand matter as being the substrate of physics (and of motion phenomena).

If we now set up as an hypothesis that matter has a fundamental property that two parts cannot simultaneously occupy the same place, then the ether *must* be discontinuous. And then light becomes *not* emission or undulation, but primarily emission and secondarily undulation, thus both together.

In this connection it may be remarked that if one will *not* accept our fundamental material hypothesis for the ether as valid then the ether must be a substance, two parts of which can simultaneously occupy the same place. Indeed *one* of the two must hold, either two parts can simultaneously

occupy the same place or not—*tertium non datur.* But such a substance is not comprehensible, so that the ether falls into disuse as a means of explaining natural phenomena; consequently if one wishes to arrive at an explanation of natural phenomena with the aid of an ether, then one must attribute to the ether the above-mentioned fundamental material property and hence assume a discontinuous ether — motion would be impossible in a continuous ether! What has been said about light then follows on further consideration and by taking into account known empirical and experimental data.

We have, it may be implicitly, attributed too much significance to the apparent immaterial nature of the ether.

FURTHER EXPLANATIONS.

Thus we see that only a discontinuous ether is capable of furnishing a satisfactory explanation of natural phenomena. And according to the latest experimental results protons—H nuclei, the assumed structural units of the atoms—are the fundamental units of matter observable to the senses (*Chemical News*, cxxxvii, 149).

According to our imaginative faculty it is only through motion that these fundamental units can produce an effect whereby matter is made observable to the senses. In the case of protons it is obvious to assume this motion to be a rotation. By so doing the atoms become " proton-mills."

The stability of these proton-mills must again be sought for in the ether and hence we conceive the atoms as cyclonically stable configurations of motion in the ether. These latter can emit finer particles—electrons—and then produce the emission character of light; but the emitted rays must further produce disturbances in the surrounding ether, which we designate as undulatory phnomena. Hence by the action of the protons light becomes primarily emission and secondarily undulation — hence both together.

And the general impression from the simple and authorative collective article " Photo-Electricity," by Sir William Bragg in the *Chemical News*, cxxxvii, 154-158, is indeed this :— that the later experimental results indicate that the twofold character of light is shown in practically all known radiation phenomena. Consequently a confirmation of the fundamental structure in our conceptions.

We cannot go into detail so as to explain every separate experiment by means of our ideas but we will here take a single case. Let us take the starting-point of the article by Sir William Bragg :—

" *Light falling upon a metal plate could cause the plate to become positively charged.*"

Now light on our ideas is primarily an electron current in which the electrons are emitted in a state of rotation from the proton-mills.

At the surface of the metal plate etheric whirlpools are to be formed because of the action of the proton-mills of the plate. If the plate is electrically neutral we postulate that approximately equal numbers of the whirlpools rotate in a clockwise and an anticlockwise direction. This also holds for the electrons of the light falling on the plate as far as their rotation is concerned provided that no special experimental conditions are set up. And it makes no great demands on one's imaginative faculty to postulate that one kind of rotary motion would preferentially take up light electrons as a result of which these motions would begin to predominate; the electrical equilibrium at the surface of the plate would thus be displaced : the plate becomes electrically charged. A simultaneous emission of electrons, which is equally strong or even stronger, along the oppositely rotating whirlpools from out the plate may similarly be conceived.

Seen from this point of view it could be thought that radiations which primarily show an emission character (cathode rays, β-rays) consist of electrons which rotate more in one direction than in another. Radiations with a predominantly undulatory character would possess rotations in both directions to an equal extent or perhaps more correctly stated—in all directions.

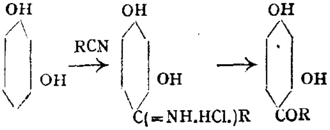
Bergen op Zoom,
Holland.
September, 1928.

Lord Melchett, accompanied by Mr. and Mrs. Henry Mond, left Southampton recently on the " Homeric," for New York. The party will proceed immediately after arrival at New York to Toronto where Lord Melchett will address the Canadian Club and thence to inspect the Mond Nickel mines and developments at Coniston, Ontario. Lord Melchett will be joined at Montreal by Sir Harry MacGowan. The party will later proceed to New York for business purposes. During his stay in the United States Lord Melchett will address various public and other bodies, including a lecture on Industrial Co-operation to the Economics Faculty at Havard. The party will return to England at the end of October.

THE APPLICATION OF THE HOESCH REACTION TO NITROBENZONITRILES

By Masataro Yamashita.

Since Hoesch synthesised various aromatic hydroxy-ketones from nitriles and certain phenols in the presence of anhydrous zinc chloride and dry hydrogen chloride, as indicated in the following scheme :—



this reaction has been applied extensively in the preparation of various aromatic carbonyl compounds. So far as I am aware, this reaction has not yet been applied to the aromatic nitriles containing a nitro-group. The synthesis of such compounds seems interesting in that the resulting compounds might be used for the preparation of the derivatives of benzophenone having various substituents in the benzene nucleus, by converting these compounds into the corresponding amino-derivatives, and then diazotising the latter. When the condensation was over and the reduction of the condensation products was in progress, Korczynski and Nowakowski had recently published the synthesis of *p*-nitrobenzoresorcinol and *p*-nitrobenzophloroglucinol for another purpose. Accordingly, the results already obtained are published in the present communication.

The present author attempted to condense resorcinol or phloroglucinol with *o*-, *m*-, and *p*-nitrobenzonitriles by the Hoesch reaction. *Whilst o-nitrobenzonitrile did not react* with resorcinol or with phloroglucinol, *m*- and *p*-nitrobenzonitriles condensed to yield the nitro-derivatives of benzophenones. The yield of the derivative of phloroglucinol was much better than that of the corresponding derivative of resorcinol.

The reduction of the condensation products is now in progress.

Experimental.

In order to improve the yield of the condensation product of resorcinol with *m*- or *p*-nitrobenzonitrile, the quantity of the components was first varied and the following were found to be the best for the purpose.

4′ - Nitro - 2 :4 - dihydroxybenzophenone, $(NO_2)C_6H_4COC_6H_3(OH)_2$. Three grams of *p*-nitrobenzonitrile and 2.5 grams of resorcinol were dissolved in 150 c.c. of absolute ether, and, after adding two grams of freshly fused and powdered zinc chloride, a gentle stream of dry hydrogen chloride was passed into the solution for five hours at room temperature, when a brownish red oil separated. After allowing the solution to remain overnight and decanting the ether, the oil was washed with ether in order to remove the unchanged *p*-nitrobenzonitrile, and boiled with 50 c.c. of water for half an hour. As the crystals thus separated were contaminated with tarry matter, they were freed from the latter by collecting them while still hot. The yield of the crude product amounted to 0.9 gram. After being recrystallised from dilute alcohol, they separated in pale yellow crystals melting at 203° (Found : C=60,29 ; H=3.59 ; N=5.97 ; Mol. wt. by the Rast method, 267. $C_{13}H_9O_5N$ requires C=60.23 ; H= 6.00 per cent. Mol. wt., 259. 1).

Korczynski and Nowakowski gave 200° as its melting point.

The Methyl Derivative, $(NO_3)C_6H_4COC_6H_3(OCH_3)_2$. 4′-Nitro-2 : 4-dihydroxybenzophenone (0.2 gram) was dissolved in 6 c.c. of a 10 per cent. solution of sodium hydroxide and shaken with 1 c.c. of methyl sulphate for an hour, when a brownish compound (0.1 gram) separated. It crystallised from a mixture of ether and petroleum ether in pale yellow crystals, m.p. 123-124° (Found : C=62.52 ; H=4.65. $C_{15}H_{13}O_5N$ requires C=62.71 ; H=1.56 per cent).

3 - Nitro - 2 : 4 - dihydroxybenzophenone, $(NO_2)C_6H_4COC_6H_3(OH)_2$. Three grams of *m*-nitrobenzonitrile and 2.5 grams of resorcinol were dissolved in 100 c.c. of absolute ether, and, after adding 3 grams of freshly fused and powdered zinc chloride, dry hydrogen chloride was gently passed into the solution for five hours at room temperature, as in the preparation of 4′-nitro2 : 4-dihydroxybenzophenone, when a reddish brown oil was deposited. After allowing it to stand overnight and decanting the ether, the oil was washed with ether, and boiled with 50 c.c. of water for half an hour, when brownish yellow crystals were obtained. In order to remove tarry matter, the crystals were collected while still hot. The yield of the crude product amounted to 0.6 gram. After being recrystallised from dilute alcohol, they separated in yellow needles melting at 228° (Found : C=60.34 ; H=3.72 ; N=6.02. $C_{13}H_9O_5N$ requires C=60.23 ; H=3.50 ; N=6.00 per cent.).

The Methyl Derivative, $(NO_2)C_6H_4COC_6H_3(OCH_3)_2$. 3′-Nitro-2 : 4-dihydroxybenzophenone (0.5 gram) was dissolved in 6 c.c. of a 10 per cent. solution of sodium hydroxide and shaken with 1 c.c. of methyl sulphate for an hour, when colourless crystals were deposited. After recrystallisation from alcohol several times, they melted at 116-117°. (Found : C=62.82; H=4.61. $C_{15}H_{13}O_5N$ requires C=62.71; H=4.56 per cent.).

4′-Nitro-2 :4 :6-trihydroxybenzophenone, $(NO_2)C_6H_4COC_6H_2(OH)_3$. One gram of freshly fused and powdered zinc chloride was added to a solution of 2 grams of *p*-nitrobenbonitrile and 1.8 grams of phloroglucinol in 100 c.c. of absolute ether, and a gentle stream of dry hydrogen chloride was passed into the solution for four hours at room temperature, when a reddish brown oil was separated. The oil was boiled for half an hour with 100 c.c. of water and the faint yellow crystals which separated were collected and recrystallised from dilute alcohol. The gamboge yellow crystals thus obtained melted at 246-247° (Found : C=56.52; H=3.52; N=4.87. $C_{13}H_9O_6N$ requires C=56.71; H=3.30; N=5.10 per cent.).

Korczynski and Nowakowski gave 244.245° as its melting point.

3′-Nitro-2 :4 :6-trihydroxybenzophenone, $(NO_2)C_6H_4COC_6H_2(OH)_3$. One and a half grams of freshly fused and powdered zinc chloride were added to a solution of four grams of m-nitrobenzonitrile and 3.6 grams of phloroglucinol in 250 c.c. of absolute ether, and a current of dry hydrogen chloride was then gently passed into the solution for six hours at room temperature. After being allowed to stand overnight, the product was freed from the unchanged nitrile, by decanting the ether and washing it several times with ether, and then decomposed by boiling with 100 c.c. of water for half an hour, or by dissolving it in 100 c.c. of $2N$-H_2SO_4 and subsequent boiling for half an hour. The yellow crystals thus separated were recrystallised from water, when they crystallised in faint, yellow needles melting at 194° (Found : C=56.44; H=3.40; N=5.05. $C_{13}H_9O_6N$ requires C=56.71; H=3.30; N=5.10 per cent.).

Attempts to condense *o*-nitrobenzonitrile with resorcinol or with phloroglucinol under various conditions were made, but without success, the unchanged nitrile being always recovered.

—*Bulletin of the Chemical Society of Japan, July*, 1928.

CHEMICAL STUDIES OF SYNTHETIC GALENA AS A RADIO DETECTOR. VI. ELECTRICAL CONDUCTIVITY.

By Wakasaburo Ogawa.

(*Abstracted from the Journal of the Society of Chemical Industry, Japan.*)

The author measured the conductivity of synthetic galena either argentiferous or non-argentiferous. Both ends of a cast rod of synthetic galena were copper-plated to eliminate any contact resistance, and the potential difference at these ends was measured when the current had a value of 100 milliamperes. According to the author a crystal of synthetic galena has a better conductivity than a natural crystal and by the addition of silver the electrical resistivity increases with its content to a certain limit. This fact may be explained as follows. In the practical method of preparing synthetic galena, formation of more or less metallic lead is inevitable which latter will give rise to a better conductivity than that of pure lead sulphide or a natural crystal. If metallic silver is added to galena containing metallic lead and fused, a part of the metallic lead in the galena particles will be transferred into silver particle, and the resistance of the mass will increase. A small quantity of silver remained in lead sulphide crystal will also exert a remarkable effect on the conductivity by increasing resistance. This explanation will be easily understood from the fact that in the metallic conductors a very small quantity of impurities may seriously affect the conductivity.

The variation of conductivity with time was observed with a platinum needle of 2.5 gms. applying d.c. of one volt in each direction. It was made clear from the result that the conductivity slowly decreases in synthetic galena without silver and increases in one containing 7.5 per cent. silver. If synthetic galena without silver has a positive temperature coefficient of resistance and one with 7.5 per cent. silver a negative coefficient, the above-mentioned change of conductivity with time may be duly ascribed to the temperature rise by current.

This was proved to be the case by the following determination of the temperature coefficient of electrical resistance. For this determination, test piece was clamped between two metallic plates insulated with bakelite and immersed into an oil bath the temperature of which was raised slowly by an electric heater. A current of 0.1 ampere was passed and the potential difference at the ends of the test piece was measured by a potentiometer. The test piece was prepared

in a cylindrical rod by casting in a mould, copper-plated on a fresh flat surface of both ends and annealed for 3 hours at 750° C. It was found that the temperature coefficient and its sign of the synthetic galena differed widely according to the compositions. Simple synthetic galenas which contain no silver have the soefficients of positive sign. Of argentiferous synthetic galena, those prepared by fusion with silver sulphide or with metallic silver and sulphur have negative coefficients except those of lower silver contents, but those crystals prepared by fusion with metallic silver only have positive coefficients. The resistance and its temperature coefficient of synthetic galenas vary after the amount of metallic lead and silver or metallographic compositions, so that is difficult to give a formula generally representing the specific resistance of a group of synthetic galena.

But the following formulas will serve to give a general idea of the nature of specific resistance of the synthetic galenas of different composition.

Specific resistance at t° between 20° and 150° C. for a crystal with 0 per cent. Ag and 1 per cent. S = 0.000411 (1 + 0.00874t).

Ditto, with 2.5 per cent Ag and 1 per cent. S = 0.05616 (1 + 0.00129 t).

Ditto, with 5 per cent Ag and 1 per cent. S = 0.3184 (1 - 0.002261 t).

Ditto, with 10 per cent. Ag and 1 per cent. S = 1.26 (1- 0116 t + 0.000047 t).

Ditto, with 0 per cent. Ag and 0 per cent. S = 0.000975 (1 + 0.01087 t)

Ditto, with 2.5 per cent. Ag and 0 per cent. S = 0.00129 (1 + 0.01247 t).

Ditto, with 7.5 per cent. Ag and 0 per cent S = 0,00214 (1 + 0.01128 t).

Ditto, with 10 per cent. Ag and 0 per cent. S = 0.003055 1 + 0.008252 t).

GENERAL NOTES.

GYPSUM INDUSTRY IN CANADA PROGRESSES.

By L. H. Cole.

Mines Branch, Department of Mines.

Gypsum is mined or quarried in Nova Scotia, New Brunswick, Ontario, Manitoba, and British Columbia, and in each of these provinces there are other properties capable of furnishing high grade material when market conditions warrant their exploitation.

The principal producing centres of gypsum in the Maritime provinces are in Cape Breton Island near Baddeck, Cheticamp, Ingonish and Mabou; at Antigonish in Antigonish county; and in Hants county in the vicinity of Windsor, Cheverie and Walton, all in Nova Scotia; in Albert county, New Brunswick, near Hillsboro', and at Plaster Rock, Victoria county, in the same province. In Nova Scotia the Canadian Gypsum Company, the Atlantic Gypsum Products Company, the Nova Scotia Coal and Gypsum Company, the Ingonish Gypsum Company and the Iona Gypsum Products, Ltd., are among the larger producers, while in New Brunswick the Albert Manufacturing Company is the principal operator. At present the greater part of the crude gypsum produced in Nova Scotia and New Brunswick is exported as such, and finds a ready market on the Atlantic seaboard of the United States. Several new companies have either recently reached the production stage or will do so within the present year, and the industry in these two provinces is showing a decided improvement.

In Ontario, the Canada Gypsum and Alabastine Limited, the only company at present operating, is maintaining its production from its Caledonia and Lythmore properties and is also operating its mill at Montreal, where Nova Scotia gypsum is used as the crude material.

The industry in Manitoba shows a marked increase both in the tonnage produced and the value of the product. Recently the Manitoba Gypsum Company, together with its subsidiary company, the British Columbia Gypsum Company, has been taken over by the Canada Gypsum and Alabastine Ltd., so that this company now has quarries and mills in all producing provinces except New Brunswick.

The province of British Columbia shows increased production from its two operating properties at Mayook and Falkland, material from the former quarry going to the cement mills while that from the Falkland deposit is being shipped for manufacture to Fort Mann, B.C., with small quantities to the cement plants.

The advances made in the gypsum industry in Canada since 1926 have been quite marked, the value for the total output for 1927 showing an increase of nearly half a million dollars over that of the previous year. The output of crude rock in the Maritime provinces shows a decided increase but probably the most important developments in this industry have taken place in the products manufactured from gypsum. A number of years ago only a small proportion of the gypsum mined in Canada was calcined in the country. In 1927 approximately

192,000 tons were calcined and made into wall plaster, gypsum wall board, gypsum blocks and insulating material.

The export trade for calcined gypsum and gypsum products is well worthy of serious study. Shipments are already being made from the Maritime provinces and British Columbia to New Zealand and points in the Orient, and there appears no reason why these export markets should not increase and be extended to the British West Indies and possibly to some of the countries of South and Central America.

EMPIRE MINING AND METALLURGICAL CONGRESS, SOUTH AFRICA, 1930.

The Prime Minister of the Union of South Africa, General the Honourable J. B. Hertzog, has issued a cordial invitation, on behalf of the Union Government, for the Third (Triennial) Empire Mining and Metallurgical Congress to be held in South Africa in 1930. This invitation was personally announced by the Minister of Mines and Industries, the Hon. F. W. Beyers, to the Second Congress assembled in Montreal, Canada, in August, 1927, and has been gladly accepted by the Empire Council of Mining and Metallurgical Institutions, on behalf of the ten constituent bodies.

A strong and influential executive committee has been appointed by the South Africal Constituent Institutions, and a particularly attractive programme is in course of preparation. The Congress will commence in Cape Town on Monday, 24 March, 1930.

A tentative itinerary has been arranged which comprises visits to all the principal mining centres in the Union and Rhodesia as well as places of scenic interest. Those attending the Congress will have the opportunity of visiting the diamond mines at Kimberley, the gold mines and works of the Witwatersrand, the gold, diamond, platinum, coal, asbestos and copper mining districts in the Transvaal, and the Sabie game reserve. The Rhodesian tour will include the Victoria Falls, one of the greatest natural sights in the world, gold, copper, zinc-lead, asbestos and coal mines, and the Zimbabwe Ruins. Members will also be enabled to visit the coal fields of Natal as well as some of the beauty spots of that Province and the Port of Durban, returning to Cape Town by a circuitous route which will take in Bloemfontein, Port Elizabeth, Oudtshoorn (Cango Caves) and the Knysna Forest. Opportunities will also be afforded of visiting some of the more important industrial developments through the country.

Sessions will probably be held in Cape Town, Kimberly, Johannesburg, Bulawayo and Durban.

The itinerary as planned provisionally, will occupy 47 days, the whole distance being a little over 7,000 miles; special trains will be provided by the South African Railway Administration, and catering and service will be on a luxury basis. While, at present, it is not possible to mention any definite amount, it is hoped that the total inclusive cost of the tour will not exceed £140. The Union Castle Mail Steamship Company, Ltd., have intimated that they will allow a special rebate of 20 per cent. off the tariff fares and it is anticipated that similar concessions on rates over other steamship lines will be granted.

Next to Great Britain, South Africa is the largest producer of mineral wealth in the Empire, particularly as regards the precious metals and diamonds. Apart, however, from the technical interest, its wonderful climate, varied and beautiful scenery and great potentialities, make it a country well worth visiting.

The Executive Committee propose to issue, from time to time, circulars dealing with the details of the programme and pahphlets or brochures containing descriptions of the places on the route of the tour.

In the meantime it is hoped that all those members of the constituent Institutions who are in a position to do so, will advise the Secretary as early as possible, of their intention to attend the Congress. By doing this they will greatly assist the Committee in their work of preparation as well as afford a guide in estimating the number of delegates who may be expected.

Those who had the privilege of attending the Congress in Canada in 1927 will remember how enjoyable the trip was from every point of view, and it is hoped to make the South African Tour equally attractive and instructive to those who are able to attend.

BOARD OF TRADE ANNOUNCEMENT.

Cotton Wool, Gauze Tissue and Sanitary Towels.

The Standing Committee appointed by the Board of Trade have reported on their enquiry as to whether imported cotton wool, gauze tissue, and sanitary towels should be required to bear an indication of origin.

The Report is obtainable from the Stationery Office, or through any bookseller, price 2d. a copy.

CHEMICAL INVESTIGATIONS IN MALAYA.

The 1927 Annual Report of the Chief Secretary to Government, Federated Malay States, states that a satisfactory method of coagulating jelutong latex by boiling has now been worked out and is being adopted by Chinese producers. Jelutong prepared in this way commands a premium on the market. Of the two kinds of deterioration common to native jelutong the development of blackening has been overcome and the cause of resinification and granulation is being studied. An investigation, moreover, has been commenced of the efficiency of the local methods of distilling alcohol from rice. The results so far obtained disclose a considerable waste of rice, in consequence of which the possibility of introducing improved methods of distillation will be examined.

SAFEGUARDING OF KEY INDUSTRIES.

BOARD OF TRADE ANNOUNCEMENT.

Representations have been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding barium nitrate and chinosol.

Section 10 (5) of the Finance Act, 1926, is as follows :—

" The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

The question of the renewal of the Safeguarding of Industries (Exemption) No. 5 Order, 1927 and Nos. 1, 2, 3, and 4 Orders, 1928, is now under consideration by the Board of Trade. The articles covered by these Orders are as follows :—

R. Acetone, Acetone (fermentation), Acetone, synthetic, Acid hydrocyanic anhydrous, Acid lactic which satisfies the requirements of the British Pharmacopœia, Acid oxalic, Amidopyrin (Pyramidon; Dimethyl amidoantipyrine), Ammonium perchlorate, Barbitone (Veronal; Malonal; Malourea; Acid diethyl barbituric; Diethylmalonylurea; Hypnogen, Deba), Bromural (Dormigene), Cocaine crude, Dial (Acid diallyl barbituric), Didial (Ethyl morphine diallyl barbiturate), Elbon (Cinnamoyl para oxyphenyl urea), Ethylene bromide, Ethylene glycol (Glycol; Alcohol ethylene), Eukodal, Furfurol, Glycol ethers, Guaiacol carbonate (Duotal), Hydroquinone, Integrators (planimeter type), R. Lead acetate, Lead tetraethyl, Lipoidin, Lithium carbonate, Lithium hydroxide, Metaldehyde, Methyl chloride, Methyl sulphonal (Diethylsulphonemethylethylmethane, Trional), Nickel hydroxide, Papaverine, Phenacetin (Acetparaphenetidine), Phenazone (Antipyrine; Phenyldimethylpyrazolone; Analgesin; Anodynine; Dimethyl oxychinizin, Phytin, Piperazine (Diethylene-diamine; Dispermin), Planimeters, R. Potassium chlorate, Potassium guaiacol sulphonate (Thiocol), R. Potassium hydroxide (R. Potassium caustic; R. Potassium hydrate), R. Potassium permanganate, Pyramidon-veronal, Quinine ethyl-carbonate, Radium compounds, Resorcine (Resorcinol), Salol (Phenyl salicylate), Styracol (Guaiacol cinnamate), Sulphonal, Synthalin, Urea (Carbamide), Vanadium-silica compounds specially prepared for use as catalysts for sulphuric acid manufacture.

Any communications with respect to the above-mentioned matters should be addressed to the Princial Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

Proceedings and Notices of Societies

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

" On a Glucoside in the Root of Pencedanum decrusvum Maxim. Part IV. Constitution of Nodakenin." By Junzo Arima.

" Adsorption of Acids and Acidic Salts.—An Explanation of the Acidity of Acidic Earth with a Note on Alkaline Earth." By Hajime Isobe and Yoshiomi Endo.

" Chlorination of Methane in the Presence of Nickel." By Kashiwa Akashi.

THE INSTITUTE OF METALS.

ANNUAL AUTUMN MEETING, LIVERPOOL.
September 5 & 6.

The α-Phase Boundary of the Copper-Silicon System. By CYRIL STANLEY SMITH, D.Sc.

The α-phase boundary of the copper-silicon system was re-determined by a series of annealing and quenching experiments. The solubility reaches its maximum value, 6.7 per cent. silicon, between 721° and 782° C. At 852° C.—the temperature of the peritectic horizontal—the solubility is 5.25 per cent., while at 400° C. is only 4.1 per cent. silicon.

The Strength of Cadmium-Zinc and Tin-Lead Solder. By C. H. M. JENKINS, B.Sc.

A comparison was made of the relative strengths in direct tension of a cadmium-zinc and a tin-lead solder under both rapid and prolonged tests, conducted at room temperature and at 120° C. Marked differences between the strengths of cast, rolled, aged, and heat-treated material have been observed. Although a general similarity in type between the two materials was found, the cadmium-zinc alloy shows markedly higher values under the various tests. The tensile strength of the cadmium-zinc alloy as ordinarily determined is approximately four times that of the tin-lead solder, but under prolonged stress tests the values obtained are approximately six times as great.

At 120° C. both materials show a considerably diminished resistance to prolonged stress, the numerical values falling to somewhat below one-tenth of those observed at room temperatures.

Practical Pyrometry. By G. B. BROCK, F.I.C., AND H. J. SIMCOX, B.Sc.

The paper outlined difficulties, such as stray current and magnetic fields of great intensity, which are peculiar to industries where large currents are used.

An instrument has been designed which eliminates these and is accurate even when placed in the field surrounding a conductor carrying as much at 20,000 amps.

Various minor difficulties are dealt with, and a description is given of a quick-reading thermocouple which is suitable for use in non-ferorus foundries.

Work-Softening of Eutectic Alloys. By F. HARGREAVES, A.R.S.M., F.I.C., AND R. J. HILLS.

The micrographic changes on working and annealing the lead-tin eutectic are studied and some explanation is offered of the existence of the critical amount of work observed at about 30 per cent. reduction. This corresponds to the same critical value previously found in ball hardness determinations.

A recrystallised sample of eutectic is found to soften when the amount of work exceeds about 20 per cent. and this shows that softening is not a peculiarity of the eutectic structure but is due to the presence of two phases. The mechanism of distortion is discussed.

Experiments on 0.5 and 15 per cent. lead tin alloys are described. The latter behaves very similarly to the eutectic, whilst the former may be rendered softer than the cast sample by working.

The cadmium-zinc eutectic after preliminary working and annealing is found to behave very similarly to the cast eutectic on being worked again.

It is considered highly probable that the phenomena investigated will be found to be operative during the hot forging of alloys containing more than one phase.

The Thermal and Microscopic Investigation of Alloys of Reactive Metals. By WILLIAM HUME-ROTHERY, M.A., Ph.D.

Methods suitable for the thermal and microscopical investigations of alloys of reactive metals were described and criticised, the subject-matter being arranged under the following headings :—

1. Methods in connection with cooling-curve experiments.

2. Materials for crucibles and thermocouple sheaths.

3. Methods for obtaining the true composition of the cooling-curve ingots at the moment of solidification.

4. The preparation of chill castings for annealing experiments.

5. Microscopic methods.

The paper discussed the justification for the method, introduced by the early German workers, in which the composition of a phase is deduced from the duration of the arrests of the cooling curves. Whilst difficult to carry out, the method is sound in the case of simple eutectic arrests where no solid solutions are formed. But in the case of peritectic reactions, or where solid solutions are present, the method is by its very nature unsound at all except very high temperatures. The best methods for use where supercooling or suspended transformation are met with are then discussed.

The Treatment of Aluminium and Aluminium Alloys with Chlorine. By D. R. Tullis.

Most aluminium alloys are known to contain dissolved gases. Various methods have been devised for their removal, and may be described as follows: The Slow Solidification method, the Inert Gas method, the Active Gas method. Various experiments are described in which chlorine gas is used as a means of removing dissolved gases. A theory is advanced to account for the presence of gases in metals. A comparison is given between the slow solidification and the chlorine methods. The results are shown by the difference obtained in the specific gravity before and after the various treatments. Further experiments describe the effects of chlorine gas on (a) alloys of aluminium which are known to extrude metal while cooling, and (b) alloys of aluminium which are known to disintegrate after long or short periods of storage.

NOTICES OF BOOKS.

Bookbinding for Schools. By J. S. Hewitt Bates. Pp. xvi 142. Leicester: Dryad Handicrafts, 42, St. Nicholas Street. 1927.

During the last few weeks much has been said of the passing and changing of old crafts, and we have the authority of Sir William Bragg that the advances in scientific knowledge do not detract from, or tend to lessen the value and liking for old crafts. On the contrary, each step which adds to our knowledge and understanding of some hitherto old-established rule of thumb method should increase interest in the old arts.

Bookbinding is a craft which should appeal in technical education both from the viewpoint that it is an art in itself and also that it may be a means of inculcating a valuable artistic and practical training. Unfortunately, it is too often neglected or omitted in school and college curricula. For those who are interested Mr. Bates' beautiful volume of information and examples may be recommended.

After several chapters on general technique, exercises are given in binding, progressing both in difficulty and in beauty of result. The value of good standards of workmanship, suitable materials and appropriate methods are duly stressed. The craft is one that offers opportunities for both technical experiment and artistic expression and could well be cultivated as a hobby by those scientists who, at week-ends, like to exchange apparatus for less delicate tools.

J. G. F. D.

Organische Chemie. By Prof. Carl Oppenheimer. Second edition. Pp. xiv + 471. Leipzig: George Thieme. 1928. Price 19 marks.

Prof. Oppenheimer's important German textbook, which is now in its second edition, deals comprehensively with the whole of Organic Chemistry. The subject is divided into General and Special parts. In the former the author describes the cause of the multiplicity of carbon compounds, chain and ring formation, types of reactions, typical homologous series, general constitution and isomerism.

The special and descriptive part is subdivided into acyclic and cyclic series, and the nitrogen bio-colloids to which increasing importance is being attached. In each section the respective groups and individual substances are described systematically. In the second edition care has been exercised to bring each section up to date and consequently much of the later parts of the book has been re-written and expanded.

Anorganische Chemie. By Prof. J. Matula and Prof. C. Oppenheimer. Second edition. Pp. xvi + 506. Leipzig: George Thieme. 1928. Price 23 m.

Like the companion volume above this Inorganic Chemistry bids fair to become one of the most widely read German Textbooks. The first part has been written by Prof. Matula of Vienna and deals with the foundadions of chemistry and stoichiometry together with other sections of physical applications, *e.g.*, electro-chemistry and photochemistry. The mode of presentation is admirably suited for university and advanced students and contains the most recent views and the work upon which these rest. The descriptive and experimental account of the metals and non-metals systematically follows the periodic classification of the elements and whilst very detailed and including the latest work, is typical of the German Handbooks. Nevertheless its completeness makes it especially valuable as a reference volume. Recently detected elements, 61 (Illinium), 43 and 75 are briefly referred to, the latter being called Rhenium and Masurium.

Das Anthracen und die Anthrachinone. By Dr. J. Houben, with the help of Dr. W. Fischer. Pp. xxiv + 890. Leipzig : George Thieme. 1928. Price 85 m.

That anthracene, anthraquinone, their derivatives and higher homologues should require a volume of 900 pages for their description is a striking testimony to the energy of those research workers who have concerned themselves with the study of these substances, which have now assumed considerable commercial importance.

The authors have spent 25 years in prepariug their volume which gives a very exhaustive account of the chemistry of the hydrocarbon and its many derivatives. There are now hundreds, possibly thousands, of anthracene and anthraquinone dyes used industrially or known to to technologists.

In this comprehensive compilation the authors have drawn upon the vast original literature. The numerous references to the work of Dr. E. de Barry Barnett and his co-workers will remind readers of his recent contributions in this *Journal*.

The patents dealing with anthracene and similar compounds and their derivatives occupy much space, too. The book is undoubtedly a valuable contrbution to the literature of applied chemistry.

PUBLICATIONS RECEIVED.

U. S. Geological Survey.

"The Ground Water Resources of the Mississippi." By L. W. Stephenson, W. N. Logan and G. A. Waring (with chemical character of the waters by C. S. Howard).

"U.S. Surface Water Supply. Part II. South Atlantic Slope and Eastern Gulf of Mexico Basins." By N. C. Grover, A. H. Horton, W. E. Hall and W. R. King.

"Part XI. Pacific Slope Basins in California." By N. C. Grover, H. D. McGlashan, and F. F. Hensham.

Bureau of Standards Soil Corrosion Studies.

"Soils, Materials and Early Observations." By K. H. Logan, S. P. Ewing, and C. D. Yeomans.

U. S. Geological Survey.

"The Molluscan Fauna of the Alum Bluff Group of Florida." By Julia Gardner. Part V.

"Economic Geology of the Castlegate, Wellington and Sunnyside Quadrangles, Caribou County, Utah." By Frank R. Clark. 75 cents.

"Surface Water Supply, Lower Mississippi River Basin." By Nathan C. Grover, H. C. Beckman, Robert Follansbee, H. B. Kinnison, and C. E. Ellsworth. 20 cents.

"Part V. Hudson Bay and Upper Mississippi Basins." By Nathan C. Grover, W. A. Lamb, S. B. Soulé, J. B. Spiegel, H. E. Grosback, and H. C. Beckman. 20 cents.

"Part XII. North Pacific Slope Drainage Basins." By Nathan C. Grover, G. C. Baldwin, G. L. Parker, C. G. Paulsen, A. B. Purton, and F. F. Henshaw. 20 cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,520.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of white titanic acid. September 5th.

25,613.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of sulphur-containing hydroxyquinones. September 6th.

25,219.—Imperial Chemical Industries, Ltd., and Wheeler, L.—Treatment of methane, etc. September 3rd.

25,216.—Wheeler, T. S.—Production of hydrogen cyanide. September 3rd.

Specifications Published.

288,571.—Schering-Kahlbaum Akt.-Ges.—Process for the manufacture of 5-iodi-2-amino-pyridine.

296,327.—I. G. Farbenindustrie Ket.-Ges. Manufacture of substituted 4.4′-dihydroxy-5 : 5′-acyl-amino-arsenobenzenes.

Abstract Published.

293,781.—Sulphonic acids.—British Dyestuffs Corporation, Ltd., Hexagon House, and Hailwood, A. J., Crumpsall Vale Chemical Works, both in Blackley, Manchester.

N :*N-Diarylsulphonylarylaminesulphonic acids* are produced by condensing arylsulphonichalides (2 mols.) with a sulphonated primary arylamine (1 mol.), or by condensing the N-monoarylsulphonylarylaminesulphonic acid (1 mol.) with an arylsulphonichalide (1 mol). The products are tanning agents and may be used as assistants in the preparation of dyes and pigments in finely

divided form. On hydrolysis with sulphuric acid both arylsulphonyl groups are removed, whilst with weak sodium hydrate one arylsulphonyl group is removed. According to examples :—(1) sodium sulphanilate (1 mol.) is condensed with *p*-toluenesulphonic-chloride (2 mol.) in the presence of sodium carbonate : (2) sodium metanilate is similarly condensed with *p*-toluenesulphonic-chloride.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

REGEDINE.

492,913.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. September 12th.

PROSAN.

492,920.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. September 12th.

REGECUTIN.

492,926.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. September 12th.

BABEX.

493,191.—Chemical substances prepared for use in medicine and pharmacy.—A Wander, Limited, 184, Queen's Gate, London, S.W.7, September 12th.

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PATENT LICENCES.

The Owners of Patent No. 222461 relating to

"Apparatus for the Synthetic Production of Ammonia and Its Elements,"

are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. Lloyd Wise & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

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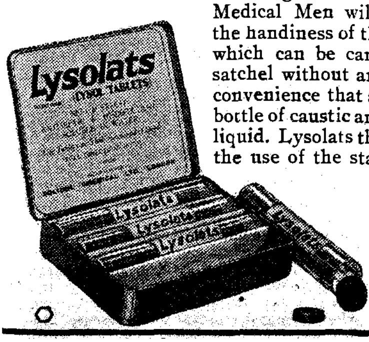

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British Association for the Advancement of Science.

SECTION B.—CHEMISTRY.

Phosphorescence, Fluorescence and Chemical Reaction.

ADDRESS BY
PROF. E. C. C. BALY, C.B.E., M.Sc., F.R.S.
PRESIDENT OF THE SECTION.

(*Concluded.*)

It will be noted that there is a marked difference between the phenomena in photoluminescence and chemical reaction at temperatures above the upper limit; since in the former phosphorescence is no longer possible, and in the latter the reaction velocity is a maximum. This difference is due to the fact that a chemical reaction is the result of a single process of activation, and when the activated molecules are set free by the resolution of their complexes the reaction takes place immediately. The phenomenon of photoluminescence is the result of a two-stage process of activation, the second stage only taking place so long as the complex is in being. When the complex is no longer stable the second stage can no longer be achieved.

It has already been pointed out that in the photosynthesis of carbohydrates the activation to the high energy level necessary for the chemical reaction is effected in two stages, namely, partial activation in the absorption complex and completion by absorption of an energy quantum at a frequency in the visible spectrum. There is therefore a close analogy between this and the activation of a phosphorogen. Since there exists in the latter an upper temperature limit above which the second stage of activation does not take place, so it is to be expected that there must be an upper temperature limit above which no photosynthesis can take place. This is actually the case, since there is a rapid decrease in the yield of carbohydrates as the temperature is increased above 31° and the reaction falls to zero at about 48°.

This decrease in efficiency is a very remarkable fact, and, as is well known, it is observed also in the living leaf. It has long been a source of difficulty to plant physiologists and the generally accepted explanation is that of F. F. Blackman, who postulates a second reaction due to an enzyme, superimposed on the first. In the laboratory experiments the Blackman reaction must obviously be absent, and in spite of this the results are remarkably analogous to those found in the living plant. The analogy is made still closer by the fact that the linear relation gives the temperature coefficient of the laboratory photosynthesis between 20° and 30° as 1.54, whereas the value found in the plant is 1.6.

This, however, is by the way, for the analogy that is particularly striking is that between photosynthesis and photoluminescence, both of which have been found to have an upper and a lower temperature limit.

The success that has attended the application of the hypothesis of complex formation to three widely differing phenomena justify its general application to all thermal chemical reactions. This naturally leads to the view that every such reaction depends on the presence of a catalyst. There seems little objection to this because it is a fact familiar to everyone that chemical reactivity suffers a most remarkable decrease as all impurities are removed. It is perhaps a sweeping statement to make that no thermal reaction can take place in the complete absence of a catalyst, but the fact remains that in every case which has been accurately examined the reaction velocity is zero. In inorganic chemistry the most effective catalyst is water and H. B. Baker's work on the absence of reaction between dry substances is classical. It may be that this power of water is connected with its great ionising power towards inorganic salts, for it is possible that ionisation itself is the result of a complex between solvent and solute.

In general, it must be remembered that every chemical reaction has its own critical increment of energy, and this means that the reactant molecules must be raised to a definite energy level which is specific for the reaction required. The catalyst molecule must, therefore, be one which by forming a complex with the reactant molecule raises it to that energy level and no other. The possibility of the same molecules being raised to different energy levels has been established by absorption spectra, since by the use of different solvents it is possible in the case of many compounds to obtain them in different physical states as evidenced by different absorption bands. The integral re-

lation has been suggested in photochemical reaction, namely

$$h\nu_0 = h\nu^1 + h\nu_2,$$

where $h\nu_0$ is the quantum absorbed at the visible or ultra-violet frequency characteristic of the reactant molecules in their initial state, $h\nu^1$ is the critical quantum of activation, and $h\nu_2$ is a quantum of fluorescence and also the quantum absorbed at the characteristic frequency of the activated molecule. If this relation be fully confirmed by further work, the different molecular states of one compound, proved by absorption spectra methods to exist in different solvents, will be directly linked up with the different chemically reactive states of that compound. The difficulty in postulating a series of catalysts which can induce different reactions of the same substance will then disappear.

We may now turn once again to the radiation hypothesis and take stock of the position. The protagonists of this theory, after enunciating the principle of a single quantum of activation, took a further step and assumed that this quantum $h\nu^1$ could be absorbed when the reactant molecules in the absence of all catalysts were exposed to radiation of the frequency ν_1. They had no justification whatever for this assumption and it is germane to ask why the fact that no substance showed an absorption band at the critical frequency ν_1 was considered to be of no great importance. The phenomena of photoluminescence afford very convincing evidence of the existence of molecules in difference states of activation, each with its own critical quantum of activation. They also establish the fact that although this critical quantum can be radiated as phosphorescence, the molecules cannot absorb it at the critical frequency. Although the activated states responsible for phosphorescence are characterised in general by their very long life periods, the fact that the activation cannot be achieved by a simple absorption process may be accepted as a proof of the incorrectness of the assumption made in the second part of the ratiation hypothesis. This evidence is independent of the *ad hoc* criticism by Lindemann and by G. N. Lewis. At the same time the evidence is in favour of the reality of the critical quanaum of activation, which is the fundamental tenet of the radiation hypothesis. An enquiry into the possible methods of activation whereby a reactant molecule can gain its critical quantum was made necessary, because the theory of activation by collision has not met with complete success, as no proper relation with photochemical activation has been established.

Photoactivation of a molecule results from the absorption of a single quantum of energy at a frequency $h\nu_0$ in the visible or ultra-violet which is specifically characteristic of the molecule in its initial state. This quantum $h\nu_0$ is invariably larger than the critical quantum of activation $h\nu_1$, and this is the explanation of Stokes' law in photoluminescence. The difference between the two quanta is radiated during the activation process as a single quantum of fluorescence, so that

$$h\nu_0 = h\nu_1 + h\nu_2.$$

The same relation has been found to hold in a photochemical reaction and fluorescence is an indication of the formation of an activated state of the molecules. In the absence of fluorescence the expected photochemical reaction does not occur, and it may be deduced from this that the quantum efficiency will approximate to unity (in the absence of the chain mechanism) when fluorescence is fully developed, and very small indeed or zero in the absence of any measurable fluorescence. The expression, given by W. C. McC. Lewis, for the observed heat of a reaction

$$Q = Nh(\nu_y - \nu_x),$$

where $h\nu_y$ and $h\nu_x$ are the critical quanta of activation of the reactant and resultant molecules, respectively, has been extended to photochemical reactions. In a monomolecular reaction which is photochemical and reversible the observed heat of reaction is given by

$$Q = Nh(\nu_r - \nu_0),$$

where ν_0 and ν_r are the characteristic ultraviolet frequencies of the reactant and resultant molecules, respectively.

A second method of activation has been suggested, namely the formation of a complex between a molecule of the reactant and a molecule of a catalyst, in which the former has gained its critical quantum of activation at the expense of the rotational energy of the latter. Such a complex will be stable and will only be resolved into its components when the defect in rotational energy of the catalyst molecule has been restored, this being possible by the absorption of infrared radiation. The result of this resolution will be the setting free of the reactant molecule in the activated state. It follows that the complex will only be stable below a certain definite temperature. As the temperature is progressively raised the stability will be progressively decreased, until a second temperature limit is reached, at which the complex has no stability. At this upper

temperature the reaction velocity will be a maximum. The observations of absorption spectra afford strong support to this hypothesis of complex formation. The particular case of the phenolic ethers has been examined in detail, and it has been found that in concentrated sulphuric acid solutions a stable state exists at 15°, in which the ether molecules have received their critical quanta of activation. A progressive increase of temperature causes a progressive increase in reaction velocity.

In applying this hypothesis to all thermal reactions it is necessary to assume first that no reaction can occur in the absence of a catalyst. This assumption seems to be justified by the known effect of the removal of all impurities on the reaction velocity. In the second place it is necessary that the catalyst activate the reactant molecule to the energy level required and no other. That this is possible is established by absorption spectra observations, which show tbat the same molecules can be raised to different energy levels within the complexes formed with different solvents. In inorganic chemistry the problem is less complicated, since in the great majority of cases only one activated state is indicated; tbis activated state exists in general within the complexes formed with water.

In the field of photoluminescence the activation is a two-stage process, since phosphorogen molecules are already partially activated in their complexes with the molecules of the diluent. The existence of these complexes is proved by the absorption frequencies of the phosphorogen, which are nearer the longer wave-lengths than those of the same substance in the free state. By photo-activation the phosphorogen molecule within the complex is raised to a higher energy level, the process being attended by the ratiation of a quantum of fluorescence. This higher energy state is stable since tbe complex still exists. It follows that there will be a temperature limit below which no phosphorescence can take place. As the temperature is progressively raised above this limit the intensity of the phosphorescence will progressively increase and the persistence will progressively decrease. When, by further increase in temperature, the region of complete instability is entered, the conditions for the special photo-activation no longer exist and all luminescence ceases. Not only are the two temperature limits of photoluminescence explained by the hypothesis of complex formation, but also the stability of the activated states.

The reaction whereby carbohydrates are photosynthesised from carbonic acid may be compared with the photo-activation of a phosphore, the initial complex being an adsorption complex of carbonic acid and nickel carbonate. There should exist, therefore, a lower temperature limit below which the reaction will not take place; an intermediate temperature zone in which the reaction will take place with a definite temperature coefficient; and an upper limit of temperature at which all reaction again ceases. These three phenomena have been observed, and the photosynthetic and photoluminescent processes proved to be analogous. In the one the highly activated molecules undergo chemical reaction, in the other they emit their critical quanta of activation as visible radiation.

It may be claimed that the evidence brought forward from the three fields of photoluminescence, absorption spectra and chemical reaction constitutes a story that is not without interest. The one dominating influence in this story is the critical quantum of activation which has found its experimental verification. In laying down the pen of authorship I do so in the confident hope that a definite step has been gained towards a radiation theory of chemical action.

ON STUDIES OF IMPROVING ESTIMATION METHODS OF IMPURITIES IN THE CRUDE CAMPHOR. II. MEASUREMENTS OF IODINE VALUES OF THE CAMPHOR AND ITS OIL.

By Seiicni Yamada and Teruji Koshitaka.

(Abstracted from the Journal of the Society of Chemical Industry, Japan.)

At the ordinary temperature the camphor oil absorbs large amount of halogen while the camphor itself absorbs little. But it is evident that the iodine value changes by various factors—kinds of the halogen solution, its concentration, its excess percentage, time of reaction and temperature—due to both addition and substitution.

The authors examined it with the iodine solution (of Hübl's and Wijs' method) and the bromine solution (of bromine acetic acid and Rosenmund's method). The experiments showed that the iodine solution was slowly absorbed and its absorption was affected by them, whilst the bromine solution was rapidly absorbed and its value varied only by hour if measured at above 90 of the halogen excess percentage and at 20° C.

THE COLLINSICS OF MINERALS. IV.

By HAWKSWORTH COLLINS, B.A. (Camb.).

Twelve more collinsics are given in Table V. Table IV. contains a list of all the combining relative volumes at 15° C. of the atoms which have so far been employed, with their corresponding O.R.'s; and also the number of times each one of these combinations has occurred in the 48 collinsics. This table may be useful to anyone who wishes to follow the matter further, as it contains many of the commonest atoms.

As said before, the discovery necessarily eliminates all impurities from minerals and other substances, and shows the thin line of truth which runs through all the experimental data.

If any error due to an experimentalist, or to a misprint, or to any other cause, with regard to any particular substance, be found, this error will not affect in the slightest any substance except the one under consideration.

The following six (at least) of the first 48 collinsics have already been proved to be true by means of Heat of Formation :—

Al_2O_3 in *Chemical News*, 1926, cxxxiii, 259.
CaO ,, ,, ,, 1924, cxxix, 96.
$CaCO_3$,, ,, ,, 1924, cxxix, 96.
$NaNO_3$,, ,, ,, 1925, cxxxiii, 403.
KNO_3 ,, ,, ,, 1927, cxxxiv, 275.
SiO_2 (quartz ,, ,, 1924, cxxix, 49.

As an example of all collinsics, No. 48 will now be explained. The first line gives the number of publication, the name, and the chemical formula. The second line gives the Theoretical S.G. followed by the experimental S.G. The third gives the result (14.992) of multiplying the sum of the atomic volumes by $\mu - 1$. The fourth gives the theoretical R.I. (μ) and also the experimental R.I. The fifth line gives the atomic refractivities and their sum (14.997). When the molecular weight (56) is divided by the sum of the atomic volumes (13.25 + 4.45) the result is the theoretical S.G. (3.164). The theoretical values must always be within 1 per cent. of the experimental, and the two results in the third and fifth lines must always agree to four figures at least.

TABLE IV.

Element	Combining Volume	O.R.	No. of times the pair occur together in the first 48 Collinsics
Na	11.865	3.865	16
Cl	15.085	10.82	3
K	22.29	7.49	9
Ca	14.54	10.52	14
Ca	13.25	13.25	9
Si	13.02	11.53	28
Si	13.83	9.78	12
Si	17.61	9.625	22
Si	18.91	10.461	23
O	7.53	1.654	69
O	4.45	1.747	31
O	2.51	1.346	269
H	5.76	2.613	106
F	5.42	0.26	4
Al	9.05	7.865	41
Al	12.05	4.863	9
N	3.8	3.8	2
Mg	8.71	6.0015	10
Mg	7.51	5.031	11
C	8.0	3.333	8
S	15.53	5.75	8

TABLE V.

THE COLLINSICS OF TWELVE MINERALS.

Theor. Column | Obs. Column

(37) Prehnite $Ca_2 + Al_2 + Si_3 + O_{11} + H_2O$

2.91 2.91 D

$87.029 = 0.6144(14.54_2 + 9.05_2 + 17.61_3 + 2.51_{11} + 14.03)$

1.6144 1.616 S

$87.023 = 10.52_2 + 7.865_2 + 9.625_3 + 1.345_{11} + 6.572$

(38) Phlogopite $K_2 + Mg_6 + Al_2 + Si_6 + O_6 + O_2 + O_{14}$

2.82 2.82 M

$168.154 = 0.5957(22.29_2 + 8.71_6 + 9.05_2 + 13.02_6 + 7.53_6 + 4.45_2 + 2.51_{14})$

1.5957 1.562 S
1.606 S

$168.155 = 7.49_2 + 6.0015_6 + 7.865_2 + 11.53_6 + 1.654_6 + 1.747_2 + 1.346_{14}$

(39) Levynite $Ca + Al_2 + Si_3 + O_8 + O_7 + 5H_2O$

2.094 2.09-2.16 D

$101.602 = 0.4971(13.25 + 12.05_2 + 18.91_3 + 7.53_8 + 2.51_7 + 14.03_5)$

1.4971 1.5 M

$101.603 = 13.25 + 4.863_2 + 10.461_3 + 1.654_8 + 1.346_7 + 6.572_5$

		Theor. Column	Obs. Column	
(40)	Wollastonite $Ca + Si + O_3$	**2.923**	2.897	Spen
			2.992	Spen
	$24.181 = 0.6094(14.54 + 17.61 + 2.51_3)$	**1.6094**	1.616	S
	$24.183 = 10.52 + 9.625 + 1.346_3$			
(41)	Aragonite $Ca + C + O + O_2$	**2.96**	2.938	Brei
			2.995	Brei
	$20.929 = 0.6192(13.25 + 8 + 7.53 + 2.51_2)$	**1.6192**	1.53013	D
			1.68157	D
	$20.929 = 13.25 + 3.333 + 1.654 + 1.346_2$			
(42)	Gypsum $Ca + S + O + O + O_2 + 2H_2O$	**2.329**	2.328	D
	$38.234 = 0.5178(13.25 + 15.53 + 7.53 + 4{,}45 + 2{,}51_2 + 14.03_2)$	**1.5178**	1.5208	D
	$38.237 = 13.25 + 5.75 + 1.654 + 1.747 + 1.346_2 + 6.572_2$			
(43)	Lime $Ca + O$	**3.164**	3.161	Kars
	$14.992 = 0.847(13.25 + 4.45)$	**1.847**	1.83	M
	$14.997 = 13.25 + 1.747$			
(44)	Scolecite $Ca + Al_2 + Si_3 + O_2 + O_8 + 3H_2O$	**2.288**	2.296	D
			2.28	Coll
	$88.156 = 0.5146(13.25 + 12.05_2 + 18.91_3 + 7{,}53_2 + 2.51_8 + 14.03_3)$	**1.5146**	1.512	S
			1.519	S
	$88.151 = 13.25 + 4.863_2 + 10.461_3 + 1.654_2 + 1.346_8 + 6.572_3$			
(45)	Albite $Na + Al + Si_3 + O_3 + O_5$	**2.63**	2.63	D
	$52.573 = 0.5276(11.865 + 9.05 + 17.61_3 + 4{,}45_3 + 2.51_5$	**1.5276**	1.53	M
	$52.576 = 3.865 + 7.865 + 9.625_3 + 1.747_3 + 1.346_5$			
(46)	Diopside $Ca + Mg + Si + Si + O_6$	**3.315**	3.2–3.38	D
	$45.905 = 0.7045(14.54 + 8.71 + 13.02 + 13{,}83 + 2.51_6)$	**1.7045**	1.70467	D
	$45.9075 = 10.52 + 6.0015 + 11.53 + 9.78 + 1.346_6$			
(47)	Serpentine $H_4 + Mg_3 + Si + Si + O + O_8$	**2.569**	2.56–2.57	D
	$62.0335 = 0.57754(5.76_4 + 8.71_3 + 13.02 + 17.61 + 7.53 + 2.51_8)$	**1.57754**	1.57	D
	$62.0335 = 2.613_4 + 6.0015_3 + 11.53 + 9.625 + 1.654 + 1.346_8$			
(48)	Pyrophyllite $Al_2 + Si_4 + O_3 + O_8 + H_2O$	**2.837**	2.8–2.9	D
	$71.421 = 0.5629(12.05_2 + 13.83_4 + 4.45_3 + 2{,}51_8 + 14.03)$	**1.5629**	1.552–1.6	S
	$71.427 = 4.863_2 + 9.78_4 + 1.747_3 + 1.346_8 + 6.572$			

O.R. = Optical Refractivity.
D = Dana
M = Miers
S = Smithsonian Publication.

There is no room for more than the first four letters of the names of experimentalists.

In Lime the value 1.847 may at first sight appear very different from 1.83, but it is within 1 per cent.

THE DREAMS OF SCIENCE.

The readers of the daily papers are bound to respect the dreams of science as a few of them are coming true. Some of the knowledge is portrayed with great accuracy, making allowance for the rapidity with which press matter passes through the hands of compositors and even editors cannot be sufficiently familiar with the various phases of science to correct minor slips tbat creep in.

It is very gratifying to see the great advances that are being made brought to public notice in this way. Yet there are some scientists who prefer things otherwise.

A few examples will illustrate the class of literature bere referred to. The readers of this Journal are familiar with Dr. Millikan's exhaustive researches in the field of cosmic rays, or strictly speaking the Hess-Kolhörster radiation. In the *Daily Mail* of September 6, 1928, under the title " The Next Sun," Dr. Millikan in his address to the members of the Society of Chemical Industry who were paying a visit to the United States, said, after describing the formation of helium, oxygen, iron, and silicon as indicated by the band analysis of the cosmic rays, that it was " a foolish dream that one day man will harness to his aid as a source of limitless power the breaking down of the atom. When our sun is exhausted he prophesied that another will have appeared enabling man's development to continue "—or words substantially to this effect. Here are *two* dreams, and it is not clear why one should be foolish and the other not, but the writer was not present to hear the address, so that in all probability Dr. Millikan made this point clear. On the top of this comes another astonishing piece of news, for in the *Daily Mail* of September 28, 1928, under the head " Water as Fuel," it is stated that at the World Power Conference at the Imperial Institute, South Kensington, London, S.W., yesterday, Walter von Hohenhau, a Brazilian scientist trained in Germany, is credited with saying that in " one experiment I was able to get so much energy out of half-an-ounce of water that a glass shield two and a half inches thick was shattered and the roof of the laboratory, measuring 60 feet by 80 feet, was carried more than 700 feet.

" Dr. von Hohenhau claimed that by applying to water very high electromagnetic vibrations he was able to release the hydrogen and then to extract further hydrogen from the oxygen.

" He said the hydrogen could be used as a gas in the same way as coal gas is used for power purposes. He added :

" From one atom [molecule] of water I can obtain 18 atoms of hydrogen. My heat units obtained from hydrogen have run an internal combustion engine for 14 days. There are about 180 cubic feet of hydrogen to a pound, and 1 lb. of hydrogen contains about 25-h.p.

" I have proved that if I apply too many vibrations a second to the water it is impossible to control it. It decomposes the hydrogen and turns water into an explosive.

" Apparatus is being built and I propose to provide industry with enough energy to run machinery for two weeks free of cost. This hydrogen gas will drive any boiler run by coal gas or petroleum, and the apparatus takes very little space. I propose to place my process before the German and British Governments simultaneously."

It is to be noted that h.p. is *rate of doing work*, so that no total amount of energy is given above, but in reporting the word *hours* might have been omitted.

Returning to the cosmic rays which are *proved*, Millikan and Cameron say—This work constitutes very powerful evidence that the atom-building processes discussed in their paper are continually going on all about us, possibly also even on the earth, and that each such event is broadcast through the heavens in the form of appropriate cosmic rays. R. D. Kleeman (*Journ. Franklin Inst.*, 1928, vol. 205, p. 691) has arrived tentatively at the likelihood of a substance at constant infinite volume having a specific heat of 1000 calories, and that that this may lead to the electrons falling through very high potentials, so that cosmic rays may be emitted in inter-stellar space, or in the outer regions of the earth's atmosphere, by atoms of H, O, N, etc., where their temperatures are very low, but can fall still lower. Jeans in his *Astronomy and Cosmogony*, advocating total annihilation of electrons and protons, says:— " Newly-generated radiation, in spite of its extreme hardness will not penetrate far

through the interior of a star without being changed on its way, so that we should expect the radiation emitted from the surface of a star to be ordinary temperature radiation, retaining no traces of its origin as radiation of extremely short wave-length. On the other hand, astronomical bodies exist which are transparent to ordinary light, so *à fortiori*, must be transparent to this high-frequency radiation. The irregular nebulæ and the outer shells of the planetary nebulæ form obvious instances, but the most important for our present purpose are the spiral and other extra-galactic nebulæ. All the radiation generated in the transparent parts of these nebulæ ought to pass without appreciable absorption or softening into outer space, so that we should expect to find space filled with high-frequency radiation of wave-length of the order of 1.3×10^{-13} cms. Here and there this radiation may devastate isolated atoms, ejecting a few million-volt electrons as it passes, but the greater part of it will pass through space unhindered until it meets a medium of substantial absorbing powers. Thus we should expect the atmosphere of the stars, sun and earth, and even the solid body of the earth, to be under continual bombardment by highly penetrating radiation of nebular origin."

It will be remembered that the transformation of mercury into gold was a false alarm, though based upon experiment. It must also be noted that theory was against this accomplishment with a limited supply of energy. Theory is sometimes stronger than fact, because the fact is not what it seems to be.

With regard to the breaking down of the atom of oxygen by "high electromagnetic vibrations," those acquainted with the energy required to do this will laugh at the idea, but I have seen most remarkable effects brought about by vibration. One is apt to be deceived by these manifestations.

F. H. L.

CALCIUM CARBIDE REDUCTION OF OXIDES.

By Robert Saxon, B.Sc., F.C.S.(Lond.), Mem.Amer.Chem.Soc.

A reflex furnace is arranged by bending the mouth of a gas-jet to throw its flame vertically downwards. This pipe is at least a little wider than the crucible used, allowing the latter to be held inside the mouth. A blowpipe playing on the underside of the crucible will turn the whole flame invisible. If an outer sleeve be provided a little larger than the pipe to enclose the crucible instead of the mouth doing so the result is a greater temperature than before. Air is taken in all round the crucible impinging on tubes all heated with greater heat of combustion. The extension of this sleeve upwards with a vertical pipe results in the gas also being considerably heated with greater caloric value.

For these experiments "straw" clay-pipes are used. These are so cheap that we do not worry when they crack after the first experiment or two. Their pores are closed by carbon obtained by calcining varnish or resin in them or paraffin-wax or a mixture of these. A number of salts may be fused in them to fill up these pores, but the clay does not take kindly to these and cracks at the second time of asking. It is always well to consider the effect of the ingredients in a reaction with a crucible upon that crucible. In a great number of cases a quartz crucible cracks sooner or later, owing to the fact that oxides have combined with it to form a very poor grade glass, with a different coefficient of expansion to the quartz it clings to. The result of course is internal stress and cracking. Some oxides will unite with calcined clay with resultant fracture. For that reason alkalis are unsuitable for aids to reduction and acid oxides decidedly so as substances to be reduced.

Calcium carbide is a powerful reducing agent especially in the presence of slaked lime. The tendency to form the carbonate is a deciding factor, for calcium carbonate does not assist the carbide in any way. Quicklime assists greatly but not so well as the hydroxide. The water probably reacts with the carbide to form acetylene.

The oxides of manganese, chromium, aluminium, magnesium, tungsten, and zirconium have yielded to the carbide, and for the first time students have seen oxides reduced, outside the confines of a text-book, with very simple apparatus. The excess of carbide is disposed of by placing the lot in water, and renewing several times. The metal in every case will displace hydrogen from sulphuric acid, or displace the brown oxides of nitrogen from strong nitric acid. Care must be taken that there is neither carbide nor carbonate about in the mixture. Some of them are very stubborn compounds towards heat, and give an effervescence which is misleading. However they will not give any visible fumes with nitric acid.

GENERAL NOTES.

MAMMOTH BRITISH INDUSTRIES FAIR.

White City Reconstruction.

Space in the London section of the British Industries Fair, to be held at White City from February 18 to March 1, is being booked up more quickly than ever before, the total stand area reserved up to date exceeding 230,000 square feet, as compared with 191,000 square feet at the same time last year.

"The increase of nearly 40,000 square feet is equivalent to the whole area of many an exhibition," an official of the Department of Overseas Trade pointed out.

"In the sections for jewellery, pottery, stationery and scientific instruments more space has been booked in each than was occupied at the Fair last February.

"The Birmingham Jewellers and Silversmiths' Association is arranging for the first time a composite exhibit with a general lounge and private cubicles where manufacturers and buyers may talk and examine samples in private and many of the Association's members will also have stands of their own.

"The Empire Marketing Board's display will include Canada for the first time and the Canadian Government, in addition, has taken a whole new hall with 7,000 square feet of stand space for a display by Canadian manufacturers.

"Apart from the addition of that hall to the Fair area, we are taking in the huge Machinery Hall which has not been used by us before. That means an addition of 100,000 square feet, more than the total stand area in what are known as the 'overhead galleries' which run all the way from Shepherd's Bush station to Wood Lane station. It will house textiles, stationery and furniture.

"To link up the Machinery Hall with the previous Fair buildings we are going to build a new hall or corridor 60 feet wide. We are also going to re-open the link between the western ends of the Court of Honour buildings so as to provide a short cut and at the same time bring into use again the restaurant there. There is also to be in the Machinery Hall a new restaurant the same size as the Empire Restaurant, which is the largest at White City.

"Replies to the Government's preliminary invitation to important overseas buyers to visit the Fair are now coming in and the countries from which acceptances have already been received include Holland, Belgium, Germany, Syria, Persia, Java, Sumatra, Australia, China, Japan, Chile and Uruguay.

"Some of the United States trade buyers and principals of firms were particularly pleased at the profitable business they were able to transact at the last Fair and as a result it is likely, we hear, that they will come in increasing numbers next February."

RECORD OUTPUT BY CANADIAN BRASS AND COPPER PRODUCTS INDUSTRY.

The Dominion Bureau of Statistics at Ottawa reports that production in 1927 by Canadian Brass and Copper products industries was valued at $24,054,647, the highest total ever recorded. The previous record production of the industry was attained in 1926 and last year's figures represent an increased output of 9 per cent., or $2,026,021.

Of the 99 plants reporting in this industry, 65 were located in Ontaria, 20 in Quebec, 7 in British Columbia, 3 in Manitoba, 2 in Nova Scotia, and 1 each in Alberta and New Brunswick. Capital employed by these firms in 1927 was $22,425,179, as compared with $20,764,404 in the previous year. Employees totalled 4,832 receiving $6,065,671 in salaries and wages, as compared to 4,533 employees and $5,716,529 in 1926.

Goods manufactured in this industry included over 21 million pounds of castings and machinery fittings; over 27 million pounds of rods; nearly 13 million pounds of plates and sheets; 3.6 million dollars' worth of brass, copper and steam fittings; about a million dollars' worth of brass wire cloth and many other lines such as railway goods, brass fittings for rubber goods, automobile hardware, bronze powders, meters, lightning rods and supplies, tanks, brass and bronze architectural work, bells and gongs, etc.

SMOKE PREVENTION AND FUEL SAVING.

The device known as the "Eddystone," which has been recently introduced to the British market and which consists of a special refractory arrangement easily applicable to the furnaces of Lancashire and other similar boilers, has already proved its success in a number of representative installations throughout the country. These devices are fitted to boilers in steel works,

textile mills, a chocolate factory, a gas works and a paper mill, as well as in other mills and factories of different types. The fuel saving and smoke prevention obtained by the use of the Eddystone has resulted in a number of repeat orders being placed for this simple and inexpensive fitting which can easily be installed at the week-end by a handy man without in any way interfering with the boiler structure.

BEHAVIOUR OF ORGANIC BASES TOWARD SOLUBLE TUNGSTATES.

By The Late Edgar F. Smith.

(*Read December 4, 1926, before The American Philosophical Society.*)

In 1861 Scheibler in his classic paper on tungstates, alluded briefly to the precipitation of tungstic acid from solutions of the 5 : 12-sodium salt (sodium paratungstate) by means of a slightly acidulated solution of quinine sulphate. The results showed that the procedure was quantitative in character but Scheibler withheld his recommendation of the method because the resulting ignited tungsten trioxide was never *yellow* in colour, but had a greenish hue.

This was the first attempt to introduce an organic base as a precipitant of tungstic acid. Some years later Allen Rogers, working in this laboratory, found that benzidine precipitated tungstic acid completely from solutions of normal tungstate $Na_2WO_4.2H_2O$). And, thereafter, v. Knorre published an interesting communication on the use of benzidine chloride, in the determination of the tungstic acid content of sodium paratungstate. It would seem that v. Knorre also used *tolidine* with success and expressed the hope that by these precipitants the separation of tungstic and phosphoric acids might be realised. However, a silence, not explained, fell upon these recomendations.

In the meanwhile, Tschilikin recommended the precipitation of the tungstic acid in sodium tungstate ($Na_2O.WO_3.2H_2O$) with alpha-naphthylamine, asserting it to be a reagent as valuable and efficacious as the bases employed by v. Knorre. Further, he analysed the alpha-napthylamine tungstate obtained by him, and from the results deduced the formula

$$2(C_{10}H_9N_2).5WO_3 + 3H_2O,$$

which doubled would be :

$$4(C_{10}H_9N_2).10WO_3 + 6H_2O,$$

analogous to Wolcott Gibbs 4 : 10-sodium salt, and for reasons known only to himself Tschilikin also analysed v. Knorre's benzidine tungstate, getting beautiful results confirmatory of the ratio two of base to five of tungstic acid, or the ratio 4 :10, confirmatory also of the ratio of the salt

$$4K_2O.10WO_3 + Aq.,$$

as deduced by Wolcott Gibbs. These were most gratifying observations in view of the doubt cast upon the ratio 4 :10 as existing between sodium oxide (Na_2O) and tungsten trioxide (WO_3), although proof of the existence of the same ratio had been given by others.

The thought suggested itself that it might be well to apply various organic bases to solutions of different soluble tungstates. In the work described in the preceding lines it was mainly with common insoluble tungstic acid, as found in normal sodium tungstate and parasodium tungstate with which the analyst dealt, although in the parasalt it (is now known that the common insoluble acid is associated with soluble or metatungstic acid. Hence, solutions of normal (1 : 1) para- (5 : 12) and meta- (1 : 4) sodium tungstates, as well as ammonium meta-tungstate, were made up with the purpose of exposing all of them to the same precipitants. It was accordingly observed that benzidine hydrochloride precipitated the preceding salt solutions completely in the form of voluminous masses, readily washed by decantation, and when filtered, dried and ignited, gave tungsten trioxide perfectly yellow in colour. The carbon burned away completely and with ease, leaving no trace of green in the residue.

Two determinations with sodium paratungstate ($5Na_2O.12WO_3 + 28H_2O$) resulted as follows :—

(*a*) 1.0348 gram salt gave 77.35 per cent. WO_3,

(*b*) 0.8699 gram salt gave 77.47 per cent. WO_3,

while the calculated percentage of tungsten trioxide in the salt is 77.37 per cent. WO_3. The precipitant employed was *benzidine acetate*. It was added to the cold tungstate solution, equalling 250 cc. in volume. The flocculent benzidine tungstate subsided promptly after the addition of a slight excess of the precipitant, and was collected upon a filter and then washed with dilute acetic cid. The dry precipitate and filter were ignited together. The ignition was easy; the residue was lemon yellow in color.

Parenthetically it may be stated that molybdic acid was also quantitatively precipitated by benzidine acetate.

A solution of pure ammonium meta-tungstate was prepared, every 5 cc. of which contained 0.4110 gram of tungsten trioxide. On precipitating two similar portions (5 cc.

each, diluted to 250 cc.) with benzidine acetate, filtering out and washing the benzidine meta-tungstate with acetic acid, igniting to WO_3 and weighing, there were obtained :

(1) 0.4118 gram WO_3,
(2) 0.4105 gram WO_3.

In these precipitations the benzidine acetate was introduced from a burette, drop by drop, under vigorous stirring. The benzidine meta-tungstate subsided quickly. The reaction was so sharp that its end could readily be noticed. Thus, for each of the 5 cc. portions of meta-tungstate solution, 6.2 cc. of the benzidine acetate were required. This interesting deportment may yet be developed into a volumetric procedure. In an additional case another portion of ammonium meta-tungstate solution, 5 cc. in volume, was diluted strongly with water and heated. The volume of benzidine acetate required for the complete precipitation was 6.6 cc. The precipitate was permitted to stand over night; removed by filtration, washed and ignited. The residue weighed 0.4096 gram WO_3, slightly lower than the theoretical.

These examples show conclusively that meta-tungstic acid is fully precipitated from solutions of its soluble salts by benzidine. Of course, this was supposed to occur, as the total tungstic acid in the sodium para-salt had been obtained on using this reagent.

It was further noticed that *aniline hydrochloride* did not precipitate solutions of normal sodium sungstate and ammonium meta-tungstate, but in a 5 : 12 solution it produced a white, curdy mass which seemed to be quantitative. However, the following singular deportment must be mentioned, *viz*,. if the 5 : 12 solution had been boiled and the *aniline hydrochloride* then added, there was no precipitation. The fact that aniline hydrochloride had precipitated the 5 : 12-salt solution in the cold, and *not* after it had been boiled, surely indicates an hydrolysis of the salt 5 : 12 into 1 : 1 and 1 : 4, neither of which when alone had been precipitated by the aniline hydrochloride.

A second attempt was made with a cold 5 : 12 solution, but the precipitation was *not* complete, as the filtrate was blued by contact with Zn and HCl.

It developed that *o-Toluidine Hydrochloride* precipitated normal sodium tungstate, ammonium meta-tungstate and the 5 : 12-salt incompletely; at least, all the filtrates were turned blue on exposure to the action of metallic zinc and hydrochloric acid.

On adding *pyridine* hydrochloride to a solution of normal sodium tungstate (1 : 1) immediate precipitation did not occur; but after twenty hours a compound had separated, in the filtrate of which a deep blue colour appeared on the addition of metallic zinc and hydrochloric acid. Incomplete precipitation was also noticed in the solution of the 5 : 12-salt, while in those of the meta-salt (1 : 4) precipitation was immediate and thought to be complete, so that two portions of an ammonium meta-solution, each containing in 5 cc. 0.2019 gram tungsten trioxide gave

a. 0.1955 gram WO_3 and 0.1840 gram WO_3.

The filtrates from these precipitates remained colourless, when acted upon with zinc and hydrochloric acid.

Three additional portions (5 cc. each) of the ammonium meta-salt solution were treated as before, every care being taken in the handling of the pyridine precipitates, which gave,

(*a*) 0.1927 gram WO_3,
(*b*) 0.1964 gram WO_3,
(*c*) 0.1984 gram WO_3.

What caused these variations from the theoretical requirements? As before, the filtrate showed no colour reaction. It has also been learned that an excess of pyridine hydrochloride exercised no solvent or deleterious effect on the pyridine metatungstate, and that 20 parts of water dissolved 1 part of pyridine meta-tungstate, although this solubility was very materially reduced by the presence of an excess of pyridine hydrochloride.

Was the colour test (with metallic zinc and hydrochloric acid) reliable or very delicate? To learn more on this point, 0.2019 gram of tungstic acid in the form of ammonium meta-tungstate was dissolved in 5 cc. of water. One cubic centimetre of this solution, equivalent to 0.0404 gram of tungstic acid, was diluted to 50 cc. and acted upon with the reducing agents. After an hour's standing, a slight purple colouration made its appearance. Again, 5 cc. of the solution in which there were 0.2019 gram of WO_3, had removed from it 1 cc.—.0404 gram WO_3, and this was diluted to 5 0cc. and tested with like result, indicating that where not more than .04 gram WO_3 was present reliance could not be placed on this particular colour reaction.

It seemed to be of interest to subject a portion of the pyridine meta-tungstate to a preliminary analysis; accordingly 1.1758 gram of the salt was dried for a period of four and again of seven hours at 100° C., when it lost 0.0288 gram. The residue and crucible weighed 14.2825 gram. After ignition it left 0.9600 gram of WO_3 or 83.26 per

cent. Assuming pyridine meta-tungstate to have the formula $(C_5H_5N)_2O.4WO_3$—the theoretical percentage of tungstic acid would be 84.21 per cent.

A second portion of pyridine meta-tungstate, treated as the first portion, gave, however, 84.21 per cent. WO_3 in complete accord with the theoretical requirement, so that it may be proper to express the formula of this interesting body as

$$(C_5H_5N)_2O.4WO_3+2H_2O.$$

It seemed advisable to try out the action of quinine sulphate or chloride on sodium salts of insoluble and soluble tungstic acid.

Using a solution of sodium meta-tungstate (5 cc. of which contained 0.2026 gram WO_3) —there resulted :

(*a*) 0.2012 gram WO_3,
(*b*) 0.2029 gram WO_3,
(*c*) 0.2028 gram WO_3,
(*d*) 0.2022 gram WO_3,
(*e*) 0.2037 gram WO_3.

In thes etrials an excess of quinine sulphate was employed. The quinine meta-tungstates were almost snow white in colour, whereas the precipitates formed in solutions of normal sodium tungstate and in sodium para-tungstate were tinged with a flesh-colour. The meta-tungstate in every case left on ignition a beautiful lemon yellow-coloured trioxide—WO_3.

Two portions (5 cc. each) of the normal salt 1 : 1) solution were precipitated with an excess of quinine sulphate from solutions o f250 cc. volume. The filtrate was made after standing two hours. The precipitates were washed with cold water containing quinine sulphate. The quantity of tungstic acid present in each instance was 0.1700 gram WO_3. There was found :

(*a*) 0.1704 gram WO_3
(*b*) 0.1697 gram WO_3.

From two other portions, after letting the quining tungstate stand an hour before filtration, there were obtained 0.1686 gram WO_3 and 0.1696 gram WO_3. The filtrates were not turned blue by action of zinc and hydrochloric acid.

In a third trial with the 1 : 1-salt solution, allowing the precipitate to stand four and a half hours before filtration, the quantity of tungstic acid obtained was 0.1700 gram, and upon still another, where the precipitate had stood twenty-four hours before filtration, there was found 0.1694 gram WO_3, so that the period during which the precipitate may stand before filtration occurs, may vary through a pretty wide range.

In none of these experiments were *blue* colourations by zinc and acid permitted finally to determine whether the precipitation had been complete; on the contrary, an aliquot portion of the filtrate was carefully evaporated to dryness and the residue examined for tungstic acid.

Turning to the 5 : 12-salt solution, it was found on precipitating it with an excess of quinine sulphate and allowing the same to stand for six days and six nights before filtration, that the resulting yellow coloured WO_3 weighed 0.1903 gram instead of 0.1907 gram required. Also, that in portions which had stood over night the resulting tungsten trioxide weighed :

(*a*) 0.1907 gram,
(*b*) 0.1907 gram.

All these trials demonstrate that tungstic acid in its insoluble and soluble form may be estimated by the use of a quinine salt in excess. Care must be exercised carefully to wash out sodium sulphate. It tends to cling to the quinine salt.

It is established that quinine and cincronine are similarly constructed; they contain one hydroxyl group, and quinine containing an additional methoxyl group is therefore methoxycinchonine, and cinchonidine is probably a stereo-isomeride of cinchonine. Because of this interesting relationship of the three basic bodies, cinchonine and cinchonidine were also studied analytically with normal, para- and meta-salts of the tungstic acid, and omitting the recital of individual experiments, it may be added that they all precipitated the acid quantitatively. It was to be expected, yet care must in all instances be observed to remove excessive sodium solts from the precipitates, otherwise the results will be high; this was particularly the case with cinchoniné precipitate solutions of sodium bolybdate, while *nitron* precipitates the latter, as well as solutions of ammonium meta-tungstate. Chromatropic acid did not affect solutions of normal or meta-sodium tungstate. It is also true that *salicin* is without effect upon solutions of normal sodium tungstate, sodium para-tungstate or sodium meta-tungstate.

The several salts studied in this work were exposed to various solvents with the hope that results might follow which would have value in determining constitution. Thus, it was observed that *nitrobenzene* had no solvent effect upon anhydrous normal sodium tungstate, sodium para-tungstate, ammonium meta-tungstate or pyridine meta-tungstate, nor was the latter soluble in *acetone*.

In *aniline*, normal sodium tungstate, sodium para-tungstate, sodium meta-tung-

state were insoluble. They behaved similarly with *pyridine*. Anhydrous normal sodium tungstate was insoluble in *carbon disulphide*.

SUMMARY.

1. That the organic bases to which reference has been made are good precipitants for the quantitative estimation of the tungstic acid content of soluble salts.

2. That both forms of tungstic acid—the ordinary insoluble acid, and soluble or meta acid—in their soluble salts, are removed by the specified bases.

3. That the blue colour reaction occasioned by metallic zinc and hydrochloric acid in solutions of tungstates is not reliable when small amounts of the tungstic acid are present; that all filtrates from precipitates should be evaporated to dryness and the residues tested for tungsten by some more dependable reagent.

4. Strong evidences are at hand that benzidine as chloride or acetate may yield a rapid and accurate means of determining tungstic acid volumetrically.

5. Certain organic solvents were applied to the various soluble tungstates and found to be valueless on the score of solubility.

THE PHOTOGRAPHIC EXHIBITION.

The 73rd annual exhibition of the Royal Photographic Society is being held from September 17 till October 13. Whilst the main concern of the exhibition is progress in pictorial photography attention is also paid to the scientific basis upon which the subject rests.

The prints hung in the principal rooms and galleries were of as high a standard technically as usual, special mention may be made of the photograph by the Japanese, Hiromu Kira, of scientific glassware. The lantern slides of travel, natural history, and scientific subjects, both in colour and black and white were unusually good. Pictures of natural history interest, *e.g.*, animal and plant studies, showed that a high level of technique has been reached in this field as indeed is the case in other branches of applied photography such as X-ray work, photo-micrography, aerial photography and cinematography. There were also exhibits of recent scientific colour work.

In the professional and trade section, new cameras with special features were on view. Plates, papers, films, especially new non-inflammable ones, colour transparencies and general accessories were shown.

THE PHARMACY ACT JUBILEE.

Pharmacists, druggists and others, on Wednesday, October 3, celebrated the jubilee of the passing of the Pharmacy Act of 1868, which not only safeguarded the general public but protected the interests of those who carried on the business of pharmacist or druggist.

Previously the sale of drugs and poisons was free and unrestricted. Any shopkeeper, without the slightest pharmaceutical training or qualification, was permitted to sell unlimited quantities of antimony, opium, corrosive sublimate, strychnine, and other toxic substances, without restriction. Britain was at that time probably the only civilised country in the world without an effective poisons and pharmacy law. Poisonings had become frequent, and only those in which arsenic was used by the poisoner had diminished as the result of the passing, in 1851, of the Arsenic Act. In 1856 Lord Campbell drew the attention of the House of Lords to the prevalence of strychnine poisonings, and pointed out that anyone might buy this deadly substance in any chemist's shop in England.

A Bill to regulate the sale of poisons was introduced in 1857, but it was opposed by the Pharmaceutical Society as impracticable, and it was not until eleven years later that a Bill passed into law. This provided that all persons, before assuming the name of "Chemist and Druggist," or keeping open shop for the vending, dispensing, and compounding of certain dangerous drugs, chemicals, and other poisonous substances enumerated in the Schedule of Poisons, should pass an examination and be registered either as pharmaceutical chemists or chemists and druggists.

The original Schedule of Poisons, in which only fifteen items appeared, has been increased from time to time, and is now most comprehensive, while there are to-day restrictions and penalties in connection with the sale of those dangerous drugs which are the subject of International Control—opium, morphine, cocaine, and heroin—of the most drastic nature.

GOVERNMENT CHEMIST'S REPORT.

The work conducted at the Government laboratories during the year ending March 31, 1928, is reviewed in the report just issued by the Government Chemist, Sir R. Robertson (price 1s. 6d., H.M. Stationery Office).

The Government laboratories perform the chemical work for most Departments of

the State, especially in connection with Customs and Excise, and during the year no less than 491,089 samples were examined. These included foods (for comparison with contract specifications, conformity with Foods and Drugs Acts and Excise duties), alcoholic beverages, waters, metals and alloys used in aircraft construction, drugs, miscellaneous stores, etc.

The report indicates a continuous growth in the analytical work of the Government Chemist and his assistants.

Proceedings and Notices of Societies

THE INSTITUTE OF METALS.

The Council of the Institute of Metals has just issued the new session's Programme of the Institute and of its local sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield, and Swansea.

An outstanding meeting is that planned for March 6, when the "Coming-of-Age" celebrations of the Institute will be held in London under the presidency of Dr. W. Rosenhain, F.R.S.

Another interesting feature is the Annual Autumn Meeting, which will be held in Düsseldorf in September. This is the first occasion that any British scientific society has held a meeting in Germany since 1914, and it is expected that the meeting will be largely attended by members from the Continent as well as from the British Isles.

The programmes of the six local Sections of the Institute are very comprehensive and cover in all 42 papers and meetings. Several of the papers will be discussed at joint sessions with other bodies, notably the Institution of Engineers and Shipbuilders in Scotland, the Institute of British Foundrymen, the Birmingham Metallurgical Society, and the Staffordshire Iron and Steel Institute. These joint meetings constitute an important new feature in the work of the Local Sections. First developed by the Birmingham Local Section they have been extended by that Section to cover the whole of its programme of ten meetings during the session.

A novel meeting is the one arranged by the London Local Section to discuss "Some Present Day Metallurgical 'Tools' and Methods," the latter including the X-ray Spectrometer, Quantitative Spectroscope Analysis, High Magnification Microscopy, the Dilatometer, and the preparation of some unusual metallographic specimens. Short addresses by various experts on each of these subjects will be given.

The North-East Coast Local Section strikes out a new line in planning an exhibition of metallurgical preparations and products, as well as a series of visits to Works.

The Scottish Local Section has been fortunate enough to secure the President of the Institute—Dr. W. Rosenhain, F.R.S—as one of its lecturers; he will deliver an address on "Alloys; Past and Future."

Attractive programmes have also been prepared for the Sheffield and Swansea Local Sections, these covering a wide range of subjects from "Chromium Plating," and "Progress of Electric Furnaces," to "Pulverised Coal in Metallurgy" and "Recent Developments in Rolling Metal Strip and Sheet."

Altogether the programmes suggest that the Institute exhibits a considerable amount of youthful vigour notwithstanding its attainment of the age of 21, and they should result in the further strengthening of its membership, which is now verging on the 2,000 mark. Copies of the programme and invitations to the meetings can be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

Forthcoming Events.

KING'S COLLEGE, LONDON.

CENTENARY YEAR.
FACULTY OF SCIENCE.

A Course of eight public lectures on Wednesdays, at 5.30 p.m.: "The Indebtedness of Industry to Pure Science."

October 17.—Introduction. By Sir Oliver Lodge, D.Sc., LL.D., F.R.S. Chairman: The Principal of King's College.

October 24.—"The Role of Chemistry in the Life of the Nation." By A. J. Allmand, M.C., D.Sc., F.I.C., Professor of Chemistry. Chairman: The Rt. Hon. Lord Melchett.

October 31.—"Electrical Science and Industry." By Ernest Wilson, M.Inst.C.E., William Siemens Professor of Electrical Engineering. Chairman: Sir John Snell, G.B.E., M.Inst.C.E., M.I.E.E.

November 7.—"The Human Factor." By F. A. P. Aveling, M.C., D.Sc., Ph.D., Reader in Psychology. Chairman: Lord Askwith, K.C.B., M.A., D.C.L.

November 14. — "Physiology and National Efficiency." By R. J. S. McDowall, D.Sc., M.B., Ch.B., F.R.C.P. (Edin.), Professor of Physiology. Chairman: Dr. Andrew Balfour, C.B., C.M.G., M.D., D.Sc., LL.D., F.R.C.P.

November 21.—" Electrical Communication and its Indebtedness to Physics." By E. V. Appleton, M.A., D.Sc., F.R.S., Wheatstone Professor of Physics. Chairman : Senator Marconi, G.C.V.O., D.Sc., LL.D., M.Inst.C.E.

November 28.—" The Practical Applications of Zoology." By Doris L. Mackinnon, D.Sc., Professor of Zoology. Chairman : The Rt. Hon. Walter Guinness, D.S.O., M.P., Minister of Agriculture.

December 5.—.' The Relation of Botany to the Grain, Rubber and Cotton Industries." By Ruggles Gates, M.A., B.Sc., Ph.D., LL.D., F.L.S., F.R.A.I., Professor of Botany. Chairman : Sir Daniel Hall, K.C.B., M.A., D.Sc., LL.D., F.R.S.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

The Harben Lectures, 1928, will be delivered in the Lecture Theatre by Arthur T. Henderson, M.D., Lecturer in Medicine, McGill University, Montreal, on " Studies in Asthma and Related Diseases," as follows :—

Tuesday, October 23, at 4 p.m.—I. " Etiological Factors : Anaphylactic and Allergic Phenomena."

Friday, October 26, at 4 p.m. — II. " Clinical Studies of the Asthmas" :

(a) Simple or uncomplicated;
(b) Infective and reflex;
(c) Asthmatic bronchitis.

Tuesday, October 30, at 4 p.m.—III. " Clinical Studies," continued :

(a) Hay fever, seasonal and perennial;
(b) Skin manifestations; urticaria, ecxeba, angioneurotic oedema : ulceration of the cornea;
(c) Summary and conclusions.

NOTICES OF BOOKS.

Symbols and Formulæ in Chemistry. By R. M. Caven, D.Sc., and J. A. Cranston. Pp. x + 220. London : Blackie & Son. 1928. Price 9s.

This interesting volume traces chemical symbolism through the ages down to the present day, thus providing a wide survey of the development of their use in expressing chemical changes.

Symbols used by the ancients, the alchemists, of Geoffrey and Bergmann are all referred to as leading up to those used by Dalton at the beginning of last century. The clumsiness of these led to the more convenient letters introduced by Berzelius to represent atoms of the elements and since then these have undergone extension and revision with the growth of organic chemistry.

The authors describe all these developments in an entertaining way and refer to such cognate matters as the Dualistic Theory, Origins of Valency, Benzene Structural Formulæ, Complex Formulæ and the later special Theories of Valency, including Prof. Main Smith's suggestions for showing maximum and contra valencies as indicated in his work on the hydroborons (see *The Chemical News*, 1927, cxxxv, 81). Science in indebted to these authors for their interesting compilation on a subject of outstanding importance on the progress of chemistry.

Inorganic Chemistry. Vol. I. *Non-Metals.* By G. H. Bailey, D.Sc., and D. R. Snellgrove, Ph.D., M.Sc. Pp. viii + 488. London : University Tutorial Press. 1928. Price 6s. 6d.

This is a companion volume to the authors' *Inorganic Chemistry, Mainly Metals*, and is intended for students reading for Intermediate examinations. The subject matter is, therefore, treated in such a manner as to give a general survey of the whole field of the theoretical inorganic chemistry of the non-metallic clements np to the standard in view. Plenty of experiments upon which the theoretical knowledge is based are described and there are many revision questions and calculations at the end of each chapter.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

26,522.—I. G. Farbenindustrie Akt.-Ges. —Production of calcium cyanide. September 15th.

26,358.—Mortimer, J. E.—Concerting carbon dioxide, etc., in solid. September 14th.

26,333.—Rhenania-Kunheim Verein Chemischer Fabriken Akt.-Ges.—Process of working up potash salts. September 13th.

26,425.—Turek, O.—Method of producing 2, 4, 6-trinitro-3, 5-triazido-henzene. September 14th.

Specifications Published.

296,832.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of

calcium nitrate together with alumina and phosphorus.

285,451.—Riedel Akt.-Ges., J. D.—Preparation of aromatic oxyaldehydes.

Abstract Published.

294,625.—Trinitrotuluene. — Akt. - Ges. Lignose, 1, Moltkestrasse, Berlin.

Trinitrotoluene is produced by adding fused dinitrotoluene at 80-95° C., to the nitration acid at 80° C. whilst stirring, and cooling if desired, the course of the reaction and the heat developed being regulated by regulating the rate of supply of dinitrotoluene.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

BLADAN.

494,185.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. September 19th.

NOPRASEN.

494,228.—Chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. September 19th.

SULPHERICIN.

493,516.—Chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes. — Lewis Charles Wallach, 16, Finsbury Sq., London, E.C.2. September 19th.

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PATENT LICENCES.

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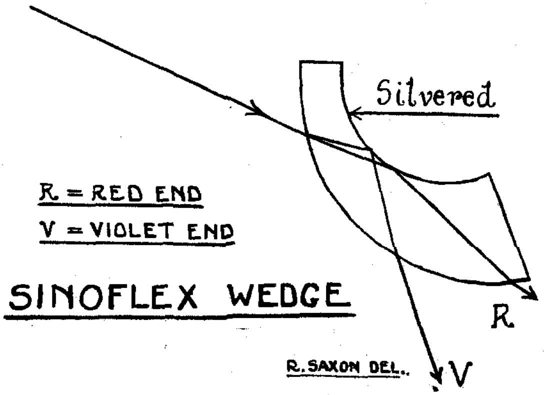
REFRACTION OF LIGHT BY QUARTZ WEDGE.

By ROBERT SAXON, B.Sc., F.C.S.

In the refraction of light through any medium the longer the path of rays inside the medium, and the greater the loss in intensity. For this reason internal reflection prisms lose too much of the violet end, and allow none of the ultra-violet to come through at all. In the constant deviation prism the path of the light will be about three times that in the ordinary equilateral prism. This lengthening of the path results in a longer, but a weaker spectrum, necessitating of course longer photographic exposure. This lengthening of path also means loss of intensity owing to spreading of the beams, and this loss increases quadratically. Treble the length of the path for one-ninth of the intensity.

A wedge of quartz, increasing in thickness from nothing to about two millimetres, three centimetres long, may be imagined bent round a cylinder three centimetres in diameter, and we have thus a "circoflected" wedge, which we might call the Sinoflex Wedge.



The sketch shews such a wedge. Its thickness is grossly exaggerated in the drawing to allow the paths of two rays to be seen, one in the red marked R, and another in the violet marked V. The dispersion is also exaggerated, but by no means so grossly as the thickness of the wedge. A wedge may be of any thickness, and would give much greater dispersion than any prism for the same internal length of path assumed by any particular ray, but our object here is to point out that, with a very well defined ribbon beam of light, well defined to prevent interference by surface reflection, we may get a dispersion greater than with the ordinary prisms.

The light is seen coming on the left from a collimator to impinge upon the surface of the wedge. The spectrum obtained is reflected by the back curved surface, and dispersed or extended according to the amount of curvature. The smaller the diameter of the back circle and of course the greater the spreading, but also the smaller the field for catching the rays. This field on the back surface is limited by the line of the spectrum where the ray strikes at a tangent to the back circle. Such ray will proceed onward without any reflection at all. In the sketch the red ray shown is about the limit, as its whole path external and internal is almost straight. With too great a diameter for the back circle internal reflection will take place on the surface where the rays should emerge. Thus the whole must be arranged to give the greatest possible field for reflection at the back, and to ensure that the emerging rays at the two ends of the spectrum do really emerge.

It will be readily understood that this wedge is not actually bent to shape. It will, however, be fixed to a cylinder with seccative, and the outer face ground down to any desired thickness. It may be made of uniform thickness, but there is a danger of the rays approaching the violet and interfering by internal reflection. The thinner the wedge and the greater the necessity of obviaeting this.

The violet rays have the shortest passage with this wedge, which is not the case with a prism. The ultra-violet have the shortest of all, but there will be a great tendency for these to pass clean through the back surface. Much even of the violet is thereby lost in the spectra obtained and described in an article in the *Journal of the Society of Chemical Industry* on Rainbow Spectra.

THE RADIUM MINES AT JACHYMOV.

It is now well known that the phenomenon of radioactivity was first observed by the French physicist, H. Becquerel, in 1896 whilst making some experiments on fluorescence in minerals. Becquerel discovered that pitchblende was able to act upon a photographic plate in the dark. This was later found to be due to the presence of small traces of radium in the uranium mineral mineral and Prof. and Mme. Curie subsequently (1912) showed that the ore from the Jáchymov (St. Joachimsthal) in N.W. Bohemia, was the richest in the new element.

Its powerful action led to extravagant claims being made concerning its efficicy in curing cancer and other retractable diseases. Its rarity and the difficulties of extracting it have caused it to be very expensive and comparatively few scientists have been able to conduct exhaustive investigations to discover its exact properties and those of its compounds. Consequently its curative values and the best modes of application have perhaps not yet been fully estimated and worked out. There is, however, evidence of a return to the invoking of its aid in curing certain diseases. Small tubes containing minute amounts of Radium Emanation are being applied especially for cancer and other growths.

The presence of radium in the uranium ores of Jáchymov has revived the mining industry there, although not to the extent that it flourished in the sixteenth century.

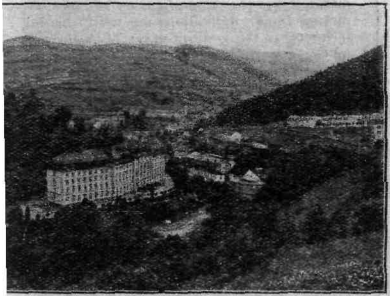
Early mining operations began in the fifteen century and were developed especially by Count Joachim Schlik who realised the value of the silver deposits. He attracted colonies of miners from Bohemia and Saxony to exploit the mines as fully as possible and his Christian name became associated with this particular valley in the Ore Mountains (German, Erzgebirge; Czechoslovak, Krušny Hory), and the town became known as Joachimsthal. The silver was minted into coins which were noted for their genuine value and they were first called "Joachimsthalers" which, however, was soon abbreviated to *Thaler*, a term which survives in the American *dollar*.

The mines became famous and attracted, among others, Georg Agricola, who spent six years in Jáchymov (1527-33) and used much of the information he gained there in his monumental *De Re Metallica*.

Gradually the silver became exhausted, and mining dwindled except for the production of small amounts of cobalt ores used in

making colours. In the middle of last century the uranium ores were found to be useful in colouring porcelain and so this mineral (pitchblende) was mined as far as the demand made it worth while re-opening the old mines.

After 1912 the uranium ores were worked up for radium preparations, but the war delayed systematic operations which only began in 1920. The high cost of the extraction and the necessarily heavy price to be put upon these potent substances has undoubtedly hindered their wide application which has further been restricted by the dangers attending anything but the most careful handling.



JACHYMOV (ST. JOACHIMSTHAL).

MARIANSKE LAZNĚ (MARIENBAD).

whose curative waters contain minute amounts of radium.

LOW TEMPERATURE CARBONISATION.

IMPORTANT COMMERCIAL DEVELOPMENTS.

By A WELL-KNOWN ENGINEER.

We now seem definitely to be on the eve of a great advance in connection with the scientific use of raw coal, equally as regards low temperature carbonisation, hydrogenation, and synthetic liquid fuel production. In this connection important commercial developments are now taking place with the "K.S.G." process of low temperature carbonisation, and we understand that a plant complete with by-product equipment, is to be installed at the well-known Mines de Lens in France, the first section of which will be one standard retort of 80 tons of coal per 24 hours throughput, using bituminous dust and smalls, for the direct manufacture, as usual, of lump smokeless fuel.

Further, it is highly interesting to learn that a second "K. S.G." plant is to be installed in Germany, while also more or less an open secret is that another "K.S.G." plant is at present under construction in Great Britain at a well-known London gas works.

The original plant at the Karnap Collieries, Essen, also with one standard retort of 80 tons of coal per 24 hours, has continued in successful commercal operation since 1924, and rapid progress is being made with the "K.G.S." installation on the Raritan River in New Jersey. This is the largest and most important low temperature carbonisation plant in the warld, consisting of 8 standard retorts, having a throughput of 640 tons of coal per 24 hours, along with extensive by-product and water gas plant, and will be ready for operation in March, 1929.

It may be stated also that the "K.S.G." process, originally a project of the late Hugo Stinnes, is controlled by the International Combustion Engineering Corporation, of "Lopulco" pulverised fuel fame, and handled in Great Britain, along with the 'McEwen-Runge" process, by Coal Oil Extraction, Ltd., of London, on the Board of which are Directors of both International Combustion Engineering Corporation of New York, and International Combustion Ltd., of London, the managing director being Mr. S. McEwen.

The "K.S.G." standard retort consists of a rotary, slightly inclined, steel cylinder, 76′ 0″ long, and 10′ 0″ in diameter, having inside a smaller cylinder 5′ 8″ diameter, whereby cheap bituminous coal dust and smalls are converted direct, as indicated, into large pieces of smokeless fuel equal or

superior in quality to graded lump coal. The cylinder is externally heated, giving a maximum temperature in the charge of about 925-1025° F., and the duration of the carbonisation is 2½ hours, corresponding to a normal throughput of 60-85 tons of bituminous coal per 24 hours, depending on the quality. Also one ton of average bituminous coal gives, as proved by the carbonisation of many thousands of tons of coal at Essen, 3595-5000 cubic feet of rich gas 800 B.Th.U. per cubic foot, 3 gallons light oil, 18-20 gallons low temperature tar, and 14 cwt. of smokeless fuel in lump form, 10-12 per cent. volatile matter, which is of a high grade quality, equally suitable for domestic or industrial use.

THE OUTLOOK FOR PLASTICS INDUSTRY.

By J. N. Taylor, U.S.A.

The increasing application of plastics in industry and their utilisation in everyday life explain their advance to a position of importance in world commerce. Particularly commanding is the position of the pyroxylins, a branch of the plastics industry which in late years has been revolutionised by the growth in the use of lacquers as paint materials for furniture and inside work as well as by automobile manufacturers .

The field of plastics embraces a number of commodities, in themselves not considered plastics, but which, however, are products of the industry taken as a whole.

Bulk of Production and Trade in Materials Manufactured from Pyroxylin.

Of those materials undoubtedly qualified to be designated as plastics, the bulk of our domestic production as well as of our foreign trade is by far in materials manufactured from pyroxylin. Under trade names such as celluloid, pyralin, viscoloid, fiberloid, and xylonite, they are well known to the public through their many applications in the manufacture of toilet ware, automobile curtains, and various other articles. Even furniture to-day is made from plastics. In 1925, according to the U.S. Bureau of the Census, the total production of pyroxylin materials, exclusive of amounts made and consumed in establishments reporting, amounted to $75,987,000, of which $48,732,000 worth constituted pyroxylin plastic solids and $27,255,000 worth pyroxylin lacquers, enamels, thinners, and solutions. These figures, when compared with a total of around $12,000,000 in 1914, reflect the growth of the industry in a little over a decade. Other plastic materials, such as casein plastics and artificial resins, occupy a secondary position, the combined production of these two classes in 1925 amounting to only $9,870,000.

The Pyroxylin Industry.

The many uses for the lower nitrated cellulose products, the pyroxylins, have given rise to an important industry. Collodion, a solution of pyroxylin in ether and alchohol, has a restricted employment in surgery and is largely used in the manufacture of photographic films and plates, making possible modern photography with all of its remarkable applications. Because of their diminished inflammability, the cellulose acetates are taking the place of the nitrates in the manufacture of motion-picture films. Collodions are used also for lacquers, in the waterproofing of cloths and in the manufacture of artificial leather for use in making belts, bags, shoes, in bookbinding, and in the manufacture of automobile upholstery and other artificial fabrics. Nitrated cellulose is the basis of one of the early French processes for the production of artificial silk.

The domestic production of all pyroxylin products—exclusive of collodion — practically doubled in the period from 1921 to 1925, inclusive. In the latter year there were produced for sale $28,000,000 worth of pyroxylin plastics and pyroxylin solutions, not including production by paint and varnish factories. Values were about evenly distributed between these two classes of pyroxylin products. The production of finished articles of pyroxylin increased in value from $2,000,000 in 1921 to $11,000,000 in 1925.

As previously mentioned, pyroxylin plastics are properly known under a variety of trade names. They are made by incorporating camphor with pyroxylin dissolved in a suitable solvent together with a stabiliser, usually urea or one of its derivatives. Other chemical compounds, such as the salts of lactic, butyric, benzoic and camphoric acids, have been suggested for this purpose. Plasticisers other than camphor, such as borneol, acetanilide, naphthalene and phenylnaphthalene, have proved useful, and esters, such as triphenyl phosphate, tricresyl phosphate and trinapthyl phosbhate, are also employed as comphor substitutes.

In the process of manufacture, the nitrocellulose or pyroxylin is worked with camphor or some other plasticiser, a stabiliser and the solvent, and the resulting mass rolled into sheets. These are then com-

pressed into blocks or other shapes. Coloured products are obtained through the incorporation of a pigment or a dye.

Many articles in common use are made from pyroxylin plastics, such as toilet sets; handles for knives, umbrellas, and brushes; collars and cuffs, beads, bracelets, billiard balls, toys, tooth brushes, rulers, fountain pens, false teeth, mosaic flooring—in fact, their application is as wide as human needs demand. Their solubility in numerous solvents make solutions of pyroxylin plastics valuable as varnishes and lacquers for automobiles and furniture.

IMPORTS OF PYROXYLIN PRODUCTS.

Imports for consumption of pyroxylin products, known as celluloid, pyralin, viscoloid, fiberloid, xylonite, or otherwise (except hard fibre), increased progressively during the years 1924, 1925, and 1926, but dropped in 1927. The total values of all products, including all forms—finished and unfinished — amounted for each of these years, respectively, to $1,557,417, $1,758,866, $2,824,460, and $2,967,215. The bulk of the import was of finished or partly finished articles. Japan supplied the major portion.

SHIPMENTS TO FOREIGN COUNTRIES.

Exports of pyroxylin plastics not made into finished or partly finished articles, in the form of sheets, rods, or tubes, decreased in 1927, as compared with 1926, as did also exports of manufactured articles. The quantity and value of outbound shipments of all products have decreased, nevertheless, the average price per pound of both classes of products has increased. Although exports to Canada have dropped considerably, that country continues to be the best customer, followed by the United Kingdom and Belgium. Australia's imports of American raw pyroxylin plastics decreased considerably while the value of shipments to Japan increased. Shipments to British India dropped from $4,000 in 1926 to a tenth as much in 1927, and to New Zealand from $2,500 in 1926 to a third of this amount in 1927.

Another class of plastie materials now receiving considerable attention is manufactured from casein, the principal protein substance found in milk. Upon treatment with formaldehyde, a tough material, white and hornlike in appearance, is formed. It is non-inflammable and capable of taking a high polish. Dyes may be incorporated with it or pigments or fillers used to produce a mottled effect. The resulting appearance rivals that of ivory, coral, tortoise shell, and similar natural products. It is at present used for buttons, beads, fountain pens, and in numerous other ways.

The production of this material constitutes a well-established industry in Europe, where the product is sold under the name of "galalith." Production of this material in the United States, on the other hand, is limited, and the domestic casein plastic industry is still in its infancy. Imports account for a large part of the American consumption, and in 1927 amounted to a little over $200,000 in value. Present imports are decidedly less than in 1923, nevertheless they show a tendency to increase—particularly of finished or partly finished articles.

SYNTHETIC RESINS INDUSTRY AN AMERICAN DEVELOPMENT.

The invention and application of the class of products known as synthetic resins constitute an outstanding American achievement. They were first made through the condensation of phenol with formaldehyde in the presence of ammonia or hexamethylenetetramine, but in late years the cumaron and indene resins, the so-called sulphur resins ,the urea-formaldehyde, the furfurolformaldehyde and other aldehyde resins, as well as those made from glycerine and phthalic anhydride, have come into wide application. Synthetic resins have a variety of uses, being largely consumed in the manufacture of insulating materials for use in radio apparatus, automobile parts, and as a substitute for amber, cigarette holders, and similar articles. Large quantities are employed in the preparation of varnishes and lacquers. The cumaron resins are said to be particularly adapted because of their solubility in organic solvents for the manufacture of varnishes, paints, lacquers, and other products. They are also employed in rubber mixtures as substitutes for rubber and they have been used in the production of linoleum and oilcloth.

During 1926 the world production of synthetic resins is estimated to have been 13,000 tons, as compared with 900 tons in 1921, and distributed as follows: United States, 40 per cent.; Germany, 24 per cent.; England, 16 per cent.; France, 8 per cent.; and other countries, 12 per cent. The 1927 output of synthetic resins in the United States amounted to over 13,000,000 pounds —more than double the quantity produced in 1922.

In conclusion, it may be said that the production of plastics has exhibited a remarkable growth since the inception of the industry. Despite the present lull in American export of these materials, furthermore, the

inherent worth and utility of plastics products should result in a still larger growth and a continual extension of markets at home and abroad.—*Commerce Reports.*

BITUMINOUS COAL CONFERENCE, PITTSBURG.

More than a hundred speakers representing twelve countries are tentatively listed to present papers at the Second International Conference on Bituminous Coal to be held under the auspices of the Carnegie Institute of Technology in Pittsburg, November 19 to 24, 1928, according to a preliminary programme announced by President Thomas S. Baker.

According to the plans, ten major subjects are listed for discussion in addition to the addresses of a general nature to be presented by Lord Melchett (Sir Alfred Mond), the British capitalist; Georges Claude, the eminent French scientist; Professor Fritz Hofmann, the German scientist who makes synthetic rubber from coal; Dr. F. Zur Nedden, of Germany; F. G. Tryon, of the U.S. Bureau of Mines, and others.

Major subjects to be discussed, it is expected, will include "Pulverised Fuel," "Gas Production," "Liquefaction and Hydrogenation," "Fertilisers," "Origin, Composition and Classification of Coal," "High Temperature Carbonisation," "Combustion in Furnaces," "Purification and Cleaning," "Tars and Oils," and "Low Temperature Processes."

As indicated in the list of major topics, the chief purpose of the coming conference will be to present the results of recent studies of coal that have to do with improved methods of utilisation and combustion. The list of speakers includes the world's leading authorities on the latest developments in improved utilisation of coal as a source of energy and power.

Germany will apparently be represented by the largest delegation with about twenty of her most distinguished scientists and engineers in attendance. France, England, and Canada will also be represented by comparatively large numbers of scientists who have been identified with the latest discoveries in coal research. Other countries that will be represented on the programme of speakers are Russia, Italy, Japan, Austria, Denmark, Belgium, and Jugo-Slavia. In addition, delegates have been appointed to represent governments and scientific organisations in Chile, Cuba, Czecho-Slovakia, Norway, Poland, Roumania, and Spain.

Approximately sixty of the 103 speakers already listed to participate in the proceedings, the announcement points out, will come from outside the United States.

The preliminary programme of major subjects and speakers under each follow :—

PULVERISED FUEL.

"Pulverised Fuel Conveying and Firing with Special Reference to Locomotives and Marine Boilers," Dr. George T. K. Blythe, general manager, The Buell Combustion Company, Ltd., London, England; "Fuel Tests and Plant Operation," Dr. Ing. M. Dolch, director, The Institute of Technical Chemistry of the University of Halle-Saale, Germany; "Adaptation of Pulverised Fuel to Marine Boilers," C. J. Jefferson, head of Fuel Conservation Section, United States Shipping Board, and Commander J. J. Broshek, Officer-in-charge, Fuel Oil Testing Plant, United States Navy; "The Powdered Coal Locomotive of the General Electric Company," Baurat Walter Kleinow, Henningsdorf, Germany; "Burning Bituminous Coals in Pulverised Form," Henry Kreisinger, research engineer, The Combustion Engineering Corporation, New York; "A Diesel Engine Using Powdered Coal," (tentative), Rudolph Pawlikowski, "Kosmos" Maschinerbauanstalt, Görlitz, Germany; "Thermodynamic Bases of Pulverised Coal Combustion," Dr. Ing. P. Rosin, Dresden, Germany; titles later, Dr. Ing. I. P. Goosens, of Messrs. Goosens, and Co., Aachen, Germany, and Professor L. E. Ramsin, director, the Thermotechnical Institute, Moscow, U.S.S.R.

GAS PRODUCTION.

"Gas and Tar Industries in France, Their Actual State and Their Tendencies," Jean Bing, Comité Central des Producteurs et Distillateurs de Goudron en France, Paris, France; "Gas Producers for Boiler Heating," William B. Chapman, director, Chapman-Stein Company, Mt. Vernon, Ohio; "Low Temperature Phantom," F. C. Greene ,The Old Ben Coal Corporation, Chicago, Ill.; "Long Distance Gas Transmission" (tentative), Dr. Alfred Pott, A. G. für Kohleverwertung, Essen an der Ruhr, Germany; "Gas for Automobile Use (tentative), C. Simon, L'Administrateur Délégue, Société pour l'Exploitation des Tubes Electro-Frettés, Paris, France; "Some Phases of the Organic Sulphur Problem in the Manufacture and Distribution of Gas," Professor Wilbert J. Huff, School of Engineering, Johns Hopkins University, Baltimore, Md.; "The Technical Lessons of the World Power Conference, 1928," and "A Study of the Comparative

Costs of Gas Production in the Retort House," Doctor E. W. Smith, technical director, Woodhall Duckham Companies, London, England.

ORIGIN, COMPOSITION AND CLASSIFICATION OF COAL. ...

"The Classification of North American Coals," A. C. Fieldner, chairman, American Engineering Standards Sectional Committee on the Classification of Coal, and chief chemist, U.S. Bureau of Mines, Washington, D.C.; "Coal and Economic Development of New Turkey," or "Black and White Coal in Austria, Dr. Bartel, Granigg, professor; "Origin of Coal," Professor E. C. Jeffrey, Harvard University, Cambridge, Mass; "Relation between the Fossil Combustibles and the Gaseous Products Resulting from their Destructive Distillation," Professor Paul Lebeau, Faculté de Pharmacie de Paris, Paris, France; "An Analytical Method for Characterising Coals by Extraction with High Boiling Organic Compounds," P. E. Raaschou, professor in Industrial Chemistry at the Royal Polytechnical College in Copenhagen, Copenhagen, Denmark; "General Considerations on the Origin and Nature of Bituminous Coals," and "The Nature and Properties of Siberian Bogheads," Dr. George L. Stadnikoff, professor of the Mining Academy and First University of Moscow, Russia; "Recent Developments in Coal Research," Dr. Reinhardt Thiessen, U.S. Bureau of Mines, Pittsburg, Pa.; title later, Dr. Chozo *Iwasaki, Tohoku Imperial University*, Sendai, Japan.

FERTILISERS.

"The Mont Cenis Process of the Fixation of Nitrogen and its Economic Importance," General Director Rudolf Battig, The Mont Cenis Process, Westphalia, Germany; "By-Product Nitrogen and the Fertiliser Industry," Charles J. Brand, executive secretary and treasurer, The National Fertiliser Association, Washington, D.C.; "Increasing Ammonia Production in Coke Making" (tentative), Professor Harry A. Curtis, Yale University, New Haven, Conn.; "The Economics of Fertilisers" (tentative), C. H. McDowell, president, The Armour Fertiliser Company, Chicago, Ill.; titles later, Louis C. Jones, president, Nitrogen Engineering Corporation, New York, N.Y., and by a representative of L'Air Liquids Société Anonyme pour l'Etude et Exploitation des Procédes Georges Claude.

LIQUEFACTION AND HYDROGENATION.

Title later, E. Aulibert, directeur de la Société Nationale de Recherches sur le Traitement des Combustibles, Senlis, France; "Recent Scientific Developments in Coal Research," Dr. Friedrich Bergius, Deutsche Chemische Gesellschaft, Heidelberg, Germany; "Oil Extraction from Coal," (tentative), R. H. Crozier, manager, Mineral Oil Extraction, Ltd., London England; "The Hydrogenation of Organic Substances at High Temperature and under High Pressure in Presence of Non-Hydrogenating Catalysers," André Kling, director, Laboratoire Municipal de la Ville de Paris, and Daniel Florentin, chemical engineer and assistant director, Laboratoire Municipal de la Ville de Paris, Paris, France; "The Hydrogenation of Tars," Professor Hugel, L'Ecole Superieure du Pétrole, Strasbourg, France; "Hydrogenation of Coal," Dr. Carl Krauch, director, I. G. Farbenindustrie, Ludwigshafen am Rhein, Germany; title later, Galileo Gaurdbassi, engineer, Fabrica Coloranti Bianchi, Milan, Italy.

HIGH TEMPERATURE CARBONISATION.

"Expenditure of Heat in the Coking Process," Dr. Ing. Ernst Terres, ordentlicher Professor der Chemischen Technologie und direktor des Chem. Technischen Institut der Technischen Hochschule Braunschweig, Germany; "The Dry Quenching of Coke," D. W. Wilson, vice president, Dry Quenching Equipment Corporation, New York City; title later, Edgar C. Evans, National Federation of Iron and Steel Manufacturers and honorary secretary, Institute of Fuel, Westminster, England.

PAPERS RELATING TO COMBUSTION IN FURNACES.

"Carbonised Fuel—How Will it be Burned," M. Alpern, president, American Engineering Company, Philadelphia, Pa.; "Coke Burning Domestic Boiler," Dr. Charles Brabbee, director, Institute of Thermal Research, Yonkers, N.Y.; "A New Method for the Determination of Melting Processes in Ash," Dipl-Ing. Dr. Karl Bunte, professor fur Gastechnik und Brennstofferverwertung Vorstand des Gasinstitute, Karlsruhe, Germany; "Sparking and Smoking Characteristics of Coals," A. E. Cameron and K. C. Gilbart, University of Alberta, Edmonton, Canada; "Boiler Furnaces for Bituminous Coal," Professor A. G. Christie, The Johns Hopkins University, Baltimore, Md.; "Clinkering of Coal Ash in Boiler Furnaces," Thomas G. Estep, professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburg, Pa.; "Removal of Ash and Loss of Carbon from Boiled Furnaces," Dr. David S.

Jacobus, advisory engineer, Babcock and Wilcox Company, New York, N.Y., and E. G. Bailey, president, Fuller Lehigh Company, Cleveland, Ohio; " Clinker Formation " (tentative), W. D. Langtry, president, Commercial Testing and Engineering Co., Chicago, Ill.; titles later, C. J. Goodwin, consulting chemical engineer, London, England; Eugene McAuliffe, president, Union Pacific Coal Company, Omaha, Nebraska, and W. L. Robinson, superintendent of fuel and locomotive performance, Baltimore and Ohio Railroad, Baltimore, Md.

PURIFICATION AND CLEANING.

" Interpretation of Float and Sink Data " (tentative), Byron M. Bird, supervising engineer, Southern Experiment Station, U. S. Bureau of Mines, Birmingham, Alabama; " Progress in the Field of Removal of Sulphur from Gases," Professor Doctor Franz Fischer, Kaiser Wilhelm Institut for Kohlenforschung, Mulheim-Ruhr, Germany; " Theory on Washing—Wet or Air Cleaning, Rheolaveur or Jig," A. France, Cie. Internationale des Rheolaveurs, Liège, Belgium; " Coal Cleaning Problems of To-day," Dr. Karl Glinz, Professor Am der Technischen Hochschule Berlin, Bergabteilung, Berlin, Germany; " The Rational Cleaning of Coal," Dr. R. Lessing, consulting chemist and chemical engineer, London, England; " Gas Purification in Relation to Coal Sulphur," Dr. F. W. Speer, Jr., director of research, Mellon Institute, Pittsburg, Pa.; " The Reason for the Need of Clean Coal," F. R. Wadleigh, consulting fuels engineer, Consolidated Gas Company of New York, N.Y.; title later, James B. Morrow, research engineer, The Pittsburg Coal Company, Pittsburg, Pa.

LOW TEMPERATURE PROCESSES.

" Low Temperature Distillation in Large Units," Dr. A. Herz, Kohlenveredlung, A. G. Berlin, Germany; " Modern Developments in Lignite Carbonisation," Professor F. P. Kerschbaum, technical adviser, Metallbank and Metallurgische Gesellschaft, Frankfurt, Germany; " Transformation of Fine Bituminous Coal into Substitutes for Anthracite," A. Léauté, Société des Combustible Purifiés, Paris, France; Further Progress of Coal Distillation," Harald Nielsen, consulting engineer, the " L. and N." Coal Distillation Ltd., London, England; " The Conversion of Slack Coal and Fines into Lumpy Smokeless Fuel-Low Temperature Coke—by the C. T. G. Process," Josef Plassman, director, Chemisch-Technische Gesellschaft m.b.H., Duisberg, Germany; " Low Temperature Distillation of Briquettes by Superheated Steam," Paul Weiss, directeur honoraire de mines, Ingenieur-sonceil des Mines de Vicoigne, Noeux and Drocourt, Paris, France; " The Treatment of Bituminous Coals by a New Process of Coal Carbonisation (Pieters Patent Continuous System), Julian Pieters, Paris, France; " The Carbocite Process " (tentative), W. H. Allen, Jr., chemical engineer, American Gas and Electric Company, New York, N.Y.; " The Economics of Low Temperature Coal Treatment," W. A. Darrah, president, Continental Industrial Engineers, Innc., Chicago, Ill.; " The Influence of Inorganic Materials in Lignite Carbonisation," A. W. Gauger, director, Division of Mines and Mining Experiments, University of North Dakota, Grand Forks, N.D.; " The ' K.S.G ' Low Temperature Carbonisation Plant at New Brunswick, N.Y." Dr. R. P. Soule, chief technologist, International Carbonisation Company, New York, N.Y.; titles later, Charles Turner, Glasgow, Scotland; T. Ban, chemist in charge of the Testing Department of Low Temperature Carbonisation and Tar Refining, Imperial Fuel Research Institute, Tokio, Japan; J. Ivon Graham, director, Mining Research Laboratory, University of Birmingham, Birmingham, England; Henri Lafond, Compagnie Internationale pour la Fabrication des Essences et Petroles, Paris, France; Dr. Cecil H. Lander, director, Fuel Research Board, London, England; M. J. McQuade, president and treasurer, Coal Carbonisation Company, Pittsburg, Pa.; S. W. Parr, professor, University of Illinois, and president, American Chemical Society, Urbana, Ill.; Dr. Ing. Fran Podbreznik, Belgrade, Jugo-Slavia; F. S. Sinnatt, assistant director, Fuel Research Board, London, England.

TARS AND OILS.

" Composition of Tars from Lignites," Professor Dr. Fritz Frank, Technische Hochschule, Berlin, Germany; " New Catalytic Processes for the Utilisation of Coal Tar Crudes," Dr. Alphons O. Jaeger, technical director, The Selden Company, Pittsburg, Pd.; " Study of Low Temperature Tars," Professor A. Mailhe, Etude des Combustibles, Faculté des Sciences à la Sorbonne, Paris, France; " Continuous Distillation of Coal Tars and Crude Oils by Superheated Steam—The Abderhalden Process," J. V. Henri Winkler, director of the research department, Compagnie des Mines de Vicoigne, Noeux, et Drocourt, Paris, France; " Cracking of Tar Acids from Coal," Dr. J. C. Morrell, assistant director

of research, and Gustav Egloff, Universal Oil Products Company, Chicago, Ill.

GENERAL.

"Some Thoughts of an Inventor on Scientific Research and Invention," Georges Claude, Paris, France; "Synthetic Rubber from Coal" (tentative), Professor Fritz Hofmann, Schlesisches Kohlenforschunginstitut der Kaiser Wilhelm Gesellschaft, Breslau, Germany; "Coal, Hydrogen and Capital," Dr. F. Zur Nedden, Dipl.-Ing., secretary of the fuel committee of Reichskohlenrat, Berlin, Germany; "Principles of Briquetting, Coking, and Non-Coking Bituminous Coals," Professors Edgar Stansfield and W. A. Lang, University of Alberta, Edmonton, Alberta, Canada; "Some Potential Relations between Electricity and Coal Utilisation," A. T. Stuart, consulting engineer, Toronto, Canada; "Pressure Electrolyser for the Production of Hydrogen and Oxygen at High Pressure without Compressors and its Applications, especially with Regard to the Improvement of Fuel," Dr. Ing. J. E. Noeggerath, F.A.I.E.E., Berlin, Germany; "Coal Consumption as Affected by Increased Efficiency and Other Factors," Dr. Arthur D. Little, consulting engineer, Cambridge, Mass.; "The Kilowatt Hour as a Manufacturing Product," A. R. Smith, Construction Engineering Department, General Electric Company, Schenectady, N.Y.; "The Part of the Catalyst in Coal Processing," (tentative), Dr. Hugh S. Taylor, Princeton University, Princeton, N.J.; "Coal Consumption and Distribution" (tentative), F. G. Tryon, United States Bureau of Mines, Washington, D.C.; titles later, Lord Melchett (Sir Alfred Mond), London, England; Howard N. Evanson, consulting engineer, Pittsburg, Pa.; Dr. H. C. Parmelee, editor, *Chemical and Metallurgical Engineering*," New York, N.Y.; Dr. Edwin E. Slosson, director, Science Service, Washington, D.C.

BASIC CARBONATES OF BERYLLIUM.

By TSUNEKICHI NISHIMURA AND TAKEMARO YAMAMOTO.

When a double decomposition is effected between the solution of beryllium chloride constantly saturated with carbon dioxide at ordinary pressure and cooled to about 0° C., and a saturated solution of the bicarbonate of ammonium or alkali metal, we can prepare a basic beryllium carbonate containing more than 0.4 mol. to 1 mol. of BeO. In the case, however, where a solution more dilute than 1 N is treated under the same conditions, there is produced a salt having a composition similar to $3Be(OH)_2.CO_2.nH_2O$, known hitherto as the most representative. Again, the compound obtained by a double decomposition at an ordinary temperature in the absence of carbon dioxide is always of high basicity and of variable composition, and especially in boiling state there is produced beryllium hydroxide in nearly pure state.

If the deposit of basic beryllium carbonate poor in carbon dioxide be exposed under either dry or wet carbon dioxde at ordinary pressure for a long time, there is generally poduced a compound of a composition near to $3Be(OH)_2.CO_2.nH_2O$, except some rare cases resulting in compounds very rich in carbon dioxide. It is, however, doubtful that the former compound can remain stable under the said circumstance.

When to the suspension of the deposit of basic beryllium carbonate in water carbon dioxide gas is passed at 25°C for a long time, the gas is absorbed at first and there is formed a compound having a composition near to $3Be(OH)_2.CO_2.nH_2O$ which remains as such for a while, afterwards decomposing into a salt containing 0.284 mol. of CO_2 in the mean to 1 mol. of BeO,a nd then maintaining the same composition for 122 days. This composition corresponds to $7Be(OH)_2.2CO_2.mH_2O$ nearly. Again, when beryllium hydroxide was suspended in water and carbon dioxide passed thereto under the same condition as before, any substance with a constant composition was not reached even after 143 days, the last and highest quantity of CO_2 being 0.209 mol. to 1 mol. of BeO.

Beryllium carbonate is unstable in air, but in dry state the decomposition becomes noticeably slow and presents an appearance of apparent stoppage. Thus, the salt in dry state has a composition very variable according to the quantity of CO_2 in wet state and to the mode of drying.

When the deposit of beryllium carbonate of a composition near to $3Be(OH)_2.CO_2.nH_2O$ is suspended in plenty of water into which a rapid air current is passed at the rooom temperature for a long period, brisk decomposition takes place at the beginning, but after passing through two stages of stoppage, decomposition goes on till finally reaching to a substance containing 0.047 mol. of carbon dioxide to 1 mol. of BeO after 138 days. In an experiment in which beryllium hydroxide was suspended in plenty of water and air was passed in a rapid current, the quantity of carbon dioxide reached a constant value comparatively rapidly, its mean value amounting to 0.052

mol. to 1 mol. of BeO, very near to the former one. If these values be reliable altogether, that which is satisfied with carbon dioxide to 5 per cent. among the total combining power of beryllium hydroxide is stable in air and in contact with water. It requires, however, to repeat the experiments for a longer period in order to verify this fact more certainly.—*Japanese Institute of Physical and Chemical Research.*

GENERAL NOTES.

CANADIAN FERTILISER REQUIREMENTS.

The Dominion Bureau of Statistics has recently conducted, in co-operation with the Department of Agriculture, a survey of the fertiliser trade in Canada. Canada's fertiliser requirements are so far relatively small and over large areas — particularly in the Prairie Provinces—the use of agricultural fertilisers is practically non-existent.

The Survey discloses that sales of fertiliser to consumers for use in Canada during the twelve months from July 1, 1926, to June 30, 1927, aggregated 169,564 tons. In view of the fact that the area sown each year to field crops totals about 56,000,000 acres, the amount of fertiliser used by Canadian farmers works out at an average of only 6 lbs. per acre.

The review gives, however, some interesting information as to the kinds of fertiliser adopted by those Canadian farmers who are accustomed to make use of chemical manures. During the year under review 64,423 tons, or 38 per cent. of the total, were "mixed fertilisers," containing two and usually three of the primary fertiliser materials, nitrogen, phosphoric acid and potash. Of 128 mixed fertilisers on the market, 98 contained all three of these plant foods and these accounted for 90 per cent. of the sales in this class. The report points out that mixed fertilisers are sold in Canada under Government supervision with a label on every bag showing the guaranteed analysis of the product.

Ranking next to the mixed fertilisers is acid phosphate, with domestic sales aggregating 56,715 tons, or 33 per cent. of the total. Basic slag and muriate of potash each accounted for between 7 and 8 per cent., nitrate of soda for 5 per cent., and sulphate of ammonia for 4 per cent. Bone meal and tankage each exceeded one per cent. of the total, and fish meal 0.6 per cent., the quantity of this last being 1,021 tons. Ten other fertilisers were used in still smaller amounts.

The survey of the fertiliser trade in Canada discloses 68 concerns marketing fertiliser and fertiliser materials direct to the consumer. Thirty-four of these operated manufacturing establishments and in addition to domestic sales, 85,074 tons of fertiliser materials were sold for export, mostly cyanamide, ammonium sulphate, acid phosphate and tankage.

METAL PRODUCTION IN CANADA.

Bismuth.

There is no metallic bismuth made in Canada, but in the treatment of silver-cobalt ores by the smelter of the Deloro Smelting and Refining Company, small quantities of bismuth are accumulated in a bullion with lead and silver. Bismuth contained in such bullion exported to the United States in 1927 amounted to 2,072 pounds, valued at $1,003.

Cadmium.

The new cadmium plant of the Consolidated Mining and Smelting Company of Canada, at Trail, British Columbia, which began operations last December, is now steadily producing three-quarters of a ton daily which is being marketed without disturbance, such has been the expansion of demand owing to the widening use of this metal in countless lines of manufacture. This would have been a quarter of the world's supply prior to this year.

Mercury.

Prospecting and some development work was done in 1927 on cinnabar properties in the Bridge River area of the Lillooet mining division and in the Kamloops mining division of British Columbia. This ore of mercury also occurs in the same Province, in the Alberni mining division of Vancouver Island.

Tungsten.

Intensive prospecting was done during 1927 on a property in the Ovens district, Lunenburg County. Surface trenching was carried on, and later during the year a prospecting shaft was sunk to a depth of thirty feet. The surface trenching showed up a zone of slate with stringers of quartz and scheelite. Scheelite also occurs in Waverley district, Halifax County, N.S., but no work was done on this deposit in 1927.

Precious Metal Products.

The Dominion Bureau of Statistics at Ottawa has forwarded to the High Commissioner for Canada in London a Bulletin

indicating that the production of precious metal products in Canada in 1927 was valued at $11,344,618, as compared with $10,751,795 in 1926.

The 109 firms producing jewellery, clocks, watches, silver and silver-plated wares, dental gold, etc., had a capital investment of $11,238,475 and employed an average of 2,806 persons to whom $3,717,989 was paid in salaries and wages. Capital increased by approximately $700,000 over 1926.

CANADIAN SALT PRODUCTION.

The Dominion Bureau of Statistics at Ottawa reports that salt production in Canada during 1927 totalled 268,672 tons, valued at $1,614,667, an increase of 2.3 per cent. in quantity and 9.1 per cent. in value as compared with the statistics for 1926.

Exports of Canadian salt totalled 1,212 tons worth $22,793, and the Dominion imported 176,761 tons, appraised at $1,082,080.

Ontario's production was 254,181 tons, or 94.6 per cent. of the Canadian total; Nova Scotia and Alberta contributed the remainder. The Nova Scotia production was obtained from the Malagash mine in Cumberland county; Alberta's production came from the Fort McMurray District.

The Canadian salt industries produce a variety of grades to meet domestic requirements, table and dairy salt ranking as of greatest importance. While the Malagash rock salt does not bulk large in the Government statistics of production, the output from the Malagash mine is steadily increasing and this type of salt has been found particularly efficacious for curing fish, a matter of considerable importance in the Maritime Provinces. The rock salt is crushed and produced in various grades for fish curing, table use, refrigeration, etc.

It was reported recently that Imperial Chemical Industries, Ltd., had become financially interested in the Malagash salt deposit through acquiring an interest in Malagash Salt Co., Ltd. Bands of potash are found associated with the salt, and Dr. Hayes, a noted New Jersey geologist, was reported to have been retained to investigate the possibilities of recovering potash.

SASKATCHEWAN LIGNITE PLANT TO RECOMMENCE OPERATIONS.

Briquetting of Sasktechewan lignite coal is to be begun during the next two months by the Western Dominion Collieries, Ltd., which was recently acquired by British interests. The experimental plant constructed by the Dominion, Manitoba, and Saskatchewan Governments near Bienfait and operated for a number of years on the manufacture of briquettes, was taken over last spring by Western Dominion Collieries, etc., and new machinery said to cost approximately $750,000 is now being rapidly installed. Coal from the Western Dominion mine about half a mile distant wil lbe used in the commercial production of briquettes.

Improvements are also being made in the installation of up-to-date machinery to reduce production expenses in the operating mines of the Bienfait coal area, which extends over an area of 50 square miles and includes nine operating mines. Last year nearly half a million tons of the lignite coal were produced and it is anticipated that at least a similar quantity will be mined in the operating season this winter.

OVERSEAS TRADE.

The Department of Overseas Trade announce that His Majesty's Senior Trade Commissioner in South Africa, Mr. N. F. Elmslie, will be in attendance at the offices of the Department during the period October 8 to October 20. He will be prepared to grant interviews to manufacturers and merchants interested in the export of British goods to the Union of South Africa.

After the period of duty in the Department Mr. Elmslie will visit a number of industrial centres in the Provinces.

Firms desiring to meet Mr. Elmslie in London should address applications for appointments to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., quoting the reference 5038/1/28.

H.M. Consul-General at Laurenco Marques (Mr. Joseph Pyke) reports that the sum of 15,279 contos has been provided for the construction and equipment of regional infirmaries and sanitary posts in Portuguese West Africa.

Firms desirous of offering material of British manufacture can obtain further particulars of this call for tenders upon application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference Number BX. 4745 should be quoted.

GETTING AT THE FACTS.

Cost Accountants' Part in Industrial Prosperity.

Cost accountants and their part in the future industrial prosperity of Great Britain was discussed at the National Confer-

ence of the Institute of Cost and Works Accountants at Birmingham on Friday, September 28.

Mr. Alexander Ramsay, Chairman of the Engineering and Allied Employers' Association (Birmingham and Wolverhampton District), opening the Conference, said that cost and works accountants were putting industrial processes under the microscope, and making them actuarially sound. "You are a comparatively recent development," he said, "and you have grown up to meet the challenge which the intensity of our industrial life has placed upon the industrial community. I believe that in the degree that manufacturers value the skill, exactness and accumulated experience which your profession represents they will be equipped to meet the serious challenge with which they are faced."

Mr. J. A. Lacey, of Birmingham, said that one was at a serious loss to reconcile reduction in costs of production and a continuity of national expenditure at the rate of £850,000,000 per annum. It showed that the task of reducing costs was the responsibility not of one element of the community, but a service required of all sections identified in national life; those responsible for national and local government; capitalist; manufacturer; worker and distributor alike. If each and all were, in their several spheres, best in the direction of economy the result mirrored in minimising costs of production would be almost beyond conjecture. While prone to give consideration to productive costs they must not be blind to the costs of distribution, of which too little was said, and to which less attention was given. The time was getting shorter to the day when cost of distribution would yield to the searching enquiry of the expert cost accountant.

Prof. J. F. Rees (Faculty of Commerce, Birmingham University), said that one of the difficulties of the professional economist was to obtain reliable productions and distribution costs upon which to base sound conclusions. In the preparation of such figures the cost accountant was beginning to do work vital to the community.

Lord Askwith, chief guest at the evening banquet, said that waste was still rife in the land, and every little piece of waste got rid of would enable more and more British production to compete in the world. Cost accountants could also give their attention to the undue locking up of capital which existed to an enormous extent in Great Britain.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Applications for Licences in September, 1928.

The following statement relating to applications for licences under the Dyestuffs (Import Regnlation) Act, 1920, made during September has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 575, of which 487 were from merchants or importers. To these should be added 22 cases outstanding on the 31 August, making a total for the month of 597. There were dealt with as follows :—

Granted—546 (of which 511 were dealt with within 7 days of receipt).

Referred to British makers of similar products—36 (of which 30 were dealt with within 7 days of receipt).

Outstanding on 29 September—15.

Of the total of 597 applications received, 541 ,of 91 per cent., were dealt with within 7 days of receipt.

HYDROCARBON RECOVERY.

There are two methods by which liquid hydrocarbons are recovered from natural gas (*a*) compression, (*b*) solution (in oil or charcoal). If natural gas be compressed to a point where the partial pressure exerted by any component exceeds its vapour pressure at the same temerature, that component will become liquid. In this way it is possible, for example, to obtain butane and all the higher members of the paraffin family as liquids, holding in solution methane, ethane and propane. Such a liquid exposed to atmospheric temperature and pressure will be unstable and will rapidly evaporate. It is termed "wild." But if it is allowed to boil under a properly constructed fractionating tower then the gaseous components methans, ethane and propane will evaporate leaving a stabilised product containing butane and the higher homologues. Such gasoline is termed "weathered," or stabilised.

Simple compression as a means of producing gasoline is no longer practised. The operation of compressors is costly, the product "wild," and the extraction difficult to bring to completion. In conjunction with stabilisers of the fractionating tower type, however, the compression process has taken on a new lease of life, especially for rich natural gases and refinery gases.

In a hypical compression plant, 2,000,000 cubic feet of gas are dealt with per day and 5,000 gallons of gasoline are obtained. The first stage of compression is to 40 lbs. per sq. in., and the second from 40 to 250 lbs. per sq. in. The hot compressed gas from the low stage compressor is passed through a cooler and any gasoline produced is separated in a tank, the gas passing on to the high stage compressor from which a smaller separation is brought about. The gas from this last separation is residue gas substantially free from gasoline.

PULVERISED FUEL.

MARINE FIRING PROBLEMS.

A paper on "Pulverised Fuel and its Various Fields of Application," was read before the Society of Engineers at Burlington House, London, on Monday, October 1, by Dr. G. E. K. Blythe, Ph.D., B.Sc., A.M.I.E.E., F.C.S.

Dr. Blythe stated that there was no longer room for scientific scepticism concerning the future of pulverised fuel. The principle was basically sound, and success was only a question of overcoming the practical difficulties.

To secure rapid ignition and combustion and thns obtain the highest furnace temperature, turbulence in the furnace was essential, in order that the inert gases might be swept away from the coke particles, to be replaced by fresh supplies of oxygen. The measure of mixing or turbulence required was indicated by the fact that every particle of coke should come into contact with many thousand times its own volume of air, so that it might burn completely under ideal conditions.

To-day, industrial furnaces in general—re-heating, forge, annealing, and so forth—had a low standard of efficiency, with heavy production costs and much waste of fuel. For this reason, pulverised fuel, with its promise of economy and greater efficiency, deserved close attention. Two instances would indicate the advantages of pulverised fuel :—

(1) In a furnace running on tin slag, a charge requiring ten hours to work on hand firing, consumed 37½ cwt. of coal, and with pulverised fuel, the same charge was worked in seven hours with 11½ cwt. of coal.

(2) In a non-ferrous reverberating furnace an output of nine tons of metal on four tons of coal was transformed into sixteen tons of metal on three tons of coal.

In either the unit or the storage system, the first important point, apart from special problems of the conveyance of the coal, was the necessity for drying. Drying gave readier mixing and burning, and, despite opinions to the contrary, it was undoubtedly essential.

In the matter of the Pulverised, the Ball and Ring Roller types were now generally accepted as the most efficient, in that they gave consistent and continuous pulverisation to a high degree of fineness, as required, with ease of control and no need for close attention to their working.

In the Buell dispersive type burner, with its special controls governing the volume, direction, and function of the coal and air supplies, a short turbulent flame was obtained. This flame could be altered in shape and direction, with practically perfect combustion.

The general advantages of pulverised fuel might be summarised as follows :—

(1) Higher boiler plant efficiency.
(2) Ability to burn low-grade fuels.
(3) Perfect combustion.
(4) Flexibility to meet varying loads.
(5) Reduced stand-by and banking losses.
(6) Greater ease of control.
(7) Low labour costs.
(8) Convenience of transport in the boiler house.
(9) Low radiation losses.

In the application of pulverised fuel to marine firing, remarkable progress had been made recently. The introduction of the Buell forced-draught type of burner first made the use of pulverised fnel on board ship a possibility, and now that the most efficient and suitable types of bunkers, feeders, pulverisers and burners had been fonnd by experience, the marine problem could be approached with every confidence.

The boiler efficiencies obtained with oil had been duplicated, with no added difficulties in operation, and with a B.T.U. cost that was approximately one-half of that of oil. With the burner giving complete combustion within six feet of the coal cloud, as it now did, the problem of the Scotch marine boiler, with its short combustion chamber, had been met.

In brief, pulverised fuel developments had reached the stage when they were likely to produce a change in marine firing that would be in the nature of a revolution.

CORRESPONDENCE.

LONDON FEVER HOSPITAL.

(To the Editor of the CHEMICAL NEWS.)

Sir,—May I ask for the inestimable aid of publicity in your columns for the effort we are making on behalf of the London Fever

Hospital which needs the comparatively small sum of £50,000 to enable it to continue its little-known but wonderful work.

In the past 126 years this Hospital has made no such general appeal. It is the only voluntary fever hospital in and around London and thus it has to meet the needs of all those, among the millions in this densely populated area, who cannot afford private isolation and treatment and who do not wish to make use of rate-aided institutions when they or those dependent on them are stricken with one or other of the fevers—typhoid, paratyphoid, diphtheria, scarlet fever, measles, etc.

Our patron is His Majesty the King, whose interest and support are constant. I am happy and very thankful to be able to add that in Her Royal Highness the Duchess of York we have another staunch sympathiser who is giving us invaluable practical aid in raising the money. In a letter to the Lord Mayor of London Her Royal Highness offers to do anything in her power to help. We are trebly fortunate in having the whole-hearted support of the Lord Mayor himself who is making a special appeal on our behalf.

For obvious reasons a fever hospital cannot encourage visitors and we come before the public only on rare occasions. Nearly seventy years ago Charles Dickens—whose knowledge of the circumstances and difficulties of those for whom we provide was " extensive and peculiar "—knew the London Fever Hospital and wrote in praise of its beneficent services.

To-day, with heavier burdens of expense to carry and with infinitely more exacting work to do, we need, and need very sorely, £50,000 for which we now appeal. A new Isolation Building is our most pressing necessity. The existing building is beyond repair and out of date; yet isolation is the very essence of our work. Only the devotion of our staff enables us to continue in face of present worries.

We shall be thankful and very grateful for any financial help. This should be sent to the Secretary, London Fever Hospital, Liverpool Road, Islington, N.1., or to me at 1, Howick Place, S.W.1.

I am, etc.,

EBURY,

President.

Liverpool Road, N.1.
1 October, 1928.

In the current issue of *Science Progress* (October, 1928), Sir Ronald Ross reiterates his views on the dog nuisance and other matters irritating to a scientific mind and betrays impatience at official dilatoriness in connection with minor reforms needing immediate attention. That it is unhealthy to keep dogs in towns without proper provision for them so that the public pavements are constantly fouled, as is the case at present, must be self-evident to every educated mind. Sir Ronald Ross's remedy is to raise the licence fee to a figure that will considerably diminish the dog population of Britain, which is given as four millions.

It has also just been announced that Sir Ronald is hoping to dispose of his valuable and historical archives and manuscripts dealing with the discovery of the malaria-carrying mosquito, which he made some thirty years ago. It is remarkable and regrettable that he should have to resort to this means of raising money. He is, however, not the only scientist whose work for the common good has failed to secure some reward for his efforts.

Proceedings and Notices of Societies

SOCIETY OF GLASS TECHNOLOGY.

At the meeting of the Society of Glass Technology held in Bournemouth on Friday, September 21, the following papers were presented :—

The Value of the Expansion Factor of Aluminium Oxide in Glass. By I. KITAIGORODSKY AND S. RODIN.

The thermal expansion coefficient of glass depended upon its composition and rose with the increase in the percentage of alkali and lime, and fell as the content of alumina and silica increased. In calculations of the theoretical thermal expansion coefficient of glass, the value of the factor for alumina must be taken as 0.52, as previously determined by S. English and W. E. S. Turner, and not as 5.0, the value given by Winkelmann and Schott.

A Study of the Ultra-Violet Light Transmission of Glass. By D. STARKIE, M.Sc., AND PROF. W. E. S. TURNER.

Photographs of the light transmitted by seven commercial ultra-violet glasses were obtained. They were Corex, Vita-Sanalux, Holvi-, Helio-, Quartz-, Lite, and Uviol glasses. The percentage transmission as each point of the spectrum for these seven glasses was also determined, a platinum wedge photometer being used. The con-

struction of this photometer and method of using was described in detail. Transmission curves extending from a wave-length of 7000A to 2000A were shown, and a table showing the percentage of the solar ultra-violet rays cut off by ordinary glass, transmitted by each glass. The fact that the transmission was roughly proportional to the iron content was pointed out. The amount of ferrous iron was roughly 30 per cent. of the total iron. Experiments on solarisation were described. Six glasses were exposed, under the conditions that an ordinary window pane was subject to, for three months. The decrease in transmission of the solar ultra violet rays was measured. Four specially prepared laboratory glasses containing only iron and platinum as impurities, showed no change in transmission when exposed to the sun's rays or to those from an artificial source of ultra-violet light.

The second part of the paper described the results of measurements of transmission of a series of specially prepared soda-lime glasses. The parent glass was 75 per cent. SiO_2, 10 per cent. CaO, and 15 per cent. Na_2O, and ferric oxide was added in increasing amounts as the series progressed. The glasses were prepared in platinum in an electric furnace. The platinum content, which had a marked effect on the transmission was reduced as far as possible by sintering. As the iron content increased, the limit of transmission in the ultra violet moved progressively towards higher wave-lengths. Plotting iron content against wave-length limit yielded a smooth curve, from which it could be deduced, that a glass perfectly free from iron and platinum would have a limit of 2200A approximately. Curves were exhibited, showing the percentage transmission against wave-length and the development of a maximum in the yellow-green region with increasing iron content was pointed out. The difference in transmission of glasses containing ferric iron and those containing an equal quantity of ferrous iron was discussed.

Forthcoming Events.

ROYAL MICROSCOPICAL SOCIETY.

Wednesday, 17 October, at 7.30 p.m.—The following papers will be read and discussed: "An Electrically Heated Warm Stage with Compressor for use with High Power Objectives." By Mr. J. E. Barnard, F.R.S., P.R.M.S., and Mr. F. V. Welch, F.R.M.S. "Two New Ciliates from Sewer Water." By Professor E. Ghosh, M.Sc., M.D., F.Z.S., F.R.M.S.

The Biological Section will meet in the Library on Wednesday, 7 November, 1928. Hon. Secretary: Dr. James A. Murray, F.R.S.

NOTICES OF BOOKS.

The Protamines and Histones. By the late Prof. A. Kossel. Translated by Dr. W. V. Thorne, M.A. Pp. xii + 107. London: Longsmans, Green & Co. 1928. Price 9s.

The publishers are to be congratulated upon the fact that Dr. Thorne has translated the important biochemical monograph by the late Prof. Kossel.

Investigations on protamines and histones have been undertaken chiefly from biological aspects and only recently have new chemical methods been used in the study of these protein bodies which are formed in the cell nuclei.

The book deals with the separation and estimation of the bases, isolation of the mono-amino-acids, the extraction of histones from the thymus glands. The book should appeal especially to biologists and biochemists.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

27,110.—Bohme Akt.-Ges., H. T.—Preparation of aliphatic sulpho acids. September 21st.

27,180.—Geigy Akt.-Ges., J. R.—Manufacture of acid dyestuffs. September 21st.

26,797.—Hefti, F.—Production of barbituric acid compound. September 20th.

26,869.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of higher alcohols, acetone, etc. September 19th.

26,771.—Neumann, E. — Manufacture of butyl alcohol. September 18th.

Specifications Published.

267,580.—Huessy, W.—Compound of kerosene and alcohol.

267,557.—Merck & Co.—Iodine compositions.

297,009.—Chemical Products Co.—Produc-

tion of ammonium phosphate.

297,135.—Sacchi, Dr. M. Casale.—Production of hydrogen.

297,179.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of benzene and its homologues from mixtures of oxides of carbon and hydrogen.

Abstract Published.

294,958.—Hydrogen.—Koku-Kenkyujo, 8, Etchujima - Machi, Fukagawa, Tokio.

The inflammability of hydrogen and the risk of its explosion in admixture with air is diminished by addition thereto in gas or vapour state of a small amount of one or more compounds having a higher theoretical flame propagation temperature than hydrogen. The compounds used include benzene, toluene, methyl, ethyl and other alcohols, ether, paraffin hydrocarbons, methyl cyclohexane, dimethyl or diethyl selenide and other organic selenium compounds, tetramethyl tin or lead or other organic tin or lead compounds. Carbon dioxide, nitrogen, helium and other inert gases may be added to the mixture. The hydrogen so treated may be used in balloons and airships and for ammonia synthesis, oil hardening and other industrial applications of hydrogen.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

RAYGLO.

493,213.—Chemical substances prepared for use in medicine and pharmacy.—Cupal, Limited, Phœnix Mill, King Street Bridge, Blackburn. September 26th.

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PATENT LICENCES.

The Owners of Patent No. 222461 relating to

"Apparatus for the Synthetic Production of Ammonia and Its Elements,"

are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. Lloyd Wise & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

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STRUCTURE OF BORON HYDRIDES.

In *Science* for September 28, 1928, there is an interesting letter on the above subject by G. Glockler. " If the idea of the pseudo-atom (H. G. Grimm, *Zeit. f. El. Chem.*, 1925, vol. 31, 475) is extended to the hydrides of boron it is possible to write formulæ for these substances that conform more nearly to our usual notion of molecular structure than do formulæ advanced up to date. It is not necessary to involve the *K*-electrons (E. D. Eastman, *Journ. Am. Chem. Soc.*, 1922, vol. 44, 438; and E. Miller, *Zeit. f. El. Chem.*, 1925, vol. 31, 382) of the boron atom in the building of a complete octet of *L*-electrons, nor to assume boron tetra- or pentavalent (A. Stock, *Ber.*, 1926, vol. 59, 2223; and J. A. Christiansen, *Zeit. f. allg. u. anorg Chem.*, 1927, vol. 160, 395; and J. Böeseken, *Ber.*, 1925, vol. 58, 268) nor need four electron bonds be assumed (M. Huggins, *Journ. Phys. Chem.*, 1922, vol. 26, 833). In fact, on the scheme given below a whole boron chemistry can be conceived in complete analogy to carbon chemistry."

Atom	Pseudo atoms in C Chemistry	Pseudo atoms in B Chemistry
$=C=$	$=C=$	$=BH=$
$=N-$	$=CH-$	$=BH_2-$
$-O-$	$-CH_2-$	$-BH_3-$
$F-$	CH_3-	BH_4-

These structures (see radicals) are supported by argument and examples, and if the reader is interested in the valence problem of boron he can refer to the original paper by Glockler.

In the *Chemical News* (1920, vol. 120, p. 217—correction on p. 238) I discussed the question of molecular isotopes in connection with boron. In my CHEMICAL ELEMENTS, 1923, on p. 60, I discussed a pseudo-element of silver, referring to the hydride of palladium.

It seems the order of the day for problems in science to have opposite or widely differing theoretical analyses. For example, electrons behave as if they were waves, and in certain experiments they simulate X-rays (see experiments of Davisson and Germer on the one hand and G. P. Thomson on the other, both experiments giving a real physical basis for the new wave theory of mechanics, which displaces the simple orbital theory of the atom) yet electrons and Xrays are not alike in one or two respects, for the electrons are easily deflected by a magnet, whereas X-rays are not deflected at all.

It moreover, looks as if science was fast becoming a test for broadmindedness in that one has to expand the mental view to include what appear to be conflicting facts or theories.

F. H. L.

THE COLLINSICS OF MINERALS.—V.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The investigator has lately received a published statement by Dr. L. J. Spencer, F.R.S., in which the following words occur :—

" An interesting attempt to elucidate the constitution of the silicates has been made by W. L. Bragg, who has attacked the problem from an entirely new point of view. From the results arrived at by the determination of crystal structures by X-ray methods, it is suggested that the structure of silicates is governed by the arrangement of the oxygen atoms. These are assumed to be the largest of all the atoms that enter into the composition of the silicates, and the diameter assigned to them is 2.7 A. A symmetrical arrangement of such atoms, according to either the cubic or the hexagonal plan of closest packing, is supposed to form the foundation of most silicate structures. The smaller atoms of silicon and of the constituent metals merely fall into the interspaces between the oxygen atoms. In most cases it appears that the silicon atoms lie at the centre of a tetrahedral group of four oxygen atoms, as in the building unit assigned to β-quartz and tridymite. In determining the structure by X-ray methods of any particular mineral, an attempt is made to locate the precise position of each atom. The relative positions of the several atoms will then give some idea of the chemical constitution. In 1920, W. L. Bragg, in a series of calculated atomic diameters, gave that of oxygen (1.30 A) as the smallest of all the elements. To be told now that it is the largest of all is somewhat disconcerting. . . .''

It is evident from the above extract that X-ray experts have not yet come to any conclusion with regard to the relative sizes of atoms.

The problem was solved several years ago by means of the Higher Research Work, which consists of mathematically correct reasoning upon thousands of experimental data provided by numerous Research Workers. During the last ten years about fifty papers have been published by the *Chemical News* demonstrating the discovery, and now each colliusic, as it is produced, contains a separate and distinct proof of the truth of it.

In Table VII twelve more collinsics are given, and in Table VI examples are given of the manner in which the beat of formation of minerals could be brought in to corroborate the matter, if the necessary experimental data were available.

The solution of the problem was almost entirely dependent upon the discovery of the three different forms of oxygen.

Acidic oxygen has relative volume 7.53, its O.R. is 1.654, and its H.F. 32341.

Alcoholic oxygen has relative volume 4.45; its O.R. it 1.747, and H.F. 71515.

Neutral oxygen has relative volume 2.51; its optical refractivity is 1.346, and heat of formaton 96155.

There are very large differences between the three forms, so that it is easy to discover which oues are present in any substance.

The valuc -12701 for the heat of formation of silicon, when its relative volume is 17.61, was demonstrated in the *Chemical News* when the structure of silicon was nnder consideration.

The theoretical H.F. in Table VI is always within one per cent. of the experimental value, with one exception.

TABLE VI.

			Theor. H.F.	Obs. H.F.
Corundum				
	Al_2	+ O_3		
R.V.	9.05_2	+ 2.51_3	(see C.N., 1928, cxxxvi, 306)	
O.R.	7.865_2	+ 1.346_3		
H.F.	47466_2	+ 96155_3	= 383397	385800
Quartz				
	Si	O_2		
R.V.	17.61	+ 2.51_2	(see C.N., 1928, cxxxvii, 170)	
O.R.	9.625	+ 1.346_2		
H.F.	-12701	+ 96155_2	= 179609	180000
Lime				
	Ca	+ O		
R.V.	18.25	+ 4.45	(see C.N., 1928, cxxxvii. 214)	
O.R.	18.25	+ 1.747		
H.F.	59568	+ 71515	= 131083	131500

Aragonite

	Ca + C + O + O_2		
R.V.	13.25 + 8 + 7.53 + 2.51_2	(see C.N., 1928, cxxxvii, 214; 1924, cxxix, 96)	
O.R.	13.25 + 3.333 + 1.654 + 1.346_2		
H.F.	59568 − 18855 + 32841 + 96155_2	= 270864	270800
	Na + C + O + O_2		
H.F.	32747 − 18855 + 32841 + 96155_2	= 276290	278700
	Na + N + O_3		
R.V.	11.865 + 3.8 + 7.53_3	(see C.N., 1928, cxxxvi, 387).	
O.R.	3.865 + 3.8 + 1.654_3		
H.F.	32747 − 28680 + 32841_3	= 106140	110700

Nitre

	K + N + O_3		
R.V.	22.29 + 3.8 + 7.53_3	(see C.N., 1928, cxxxvi, 386).	
O.R.	7.49 + 3.8 + 1.654_3		
H.F.	44580 − 28680 + 32341_3	= 117973	119000
	Na + I		
H.F.	32747 + 36226	= 68973	69080
	K + I		
H.F.	44580 + 36226	= 80806	80130
	Al_2 + F_6		
H.F.	47466_2 + 76820_6	= 555852	550440
	Na + F		
H.F.	32747 + 76820	= 109567	109300 109720

Each one of these values in Table VI has been demonstrated several times in the preceding fifty papers. The figures given for Heat of Formation have been shown to be exactly true by the discovery of the Law of Heat of Formation (C.N. 1922, cxxv, 81).

The Law of the Collinsics is here stated for the first time as follows :—

In minerals each atom has a definite relative volume and a corresponding invariable optical refractivity.

N.B.—15° C. is always the temperature under consideration.

TABLE VII.
THE COLLINSICS OF TWELVE MINERALS.

		Theor. Column	Obs. Column	
(49)	Tremolite Ca + Mg + Mg_2 + Si_4 + O_{12}			
		3.00	3.00	M
	84.9366 = 0.6122(13.25 + 7.51 + 8.71_2 + 17.61_4 + 2.51_{12}			
		1.6122	1.6065	D
			1.6233	D
	84.936 = 13.25 + 5.031 + 6.0015_2 + 9.625_4 + 1.346_{12}			
(50)	Sillimanite Al_2 + Si + O + O_4			
		3.23	3.23	D
	32.484 = 0.6471(9.05_2 + 17.61 + 4.45 + 2.51_4)			
		1.6471	1.638 - 1.653	S
	32.486 = 7.865_2 + 9.625 + 1.747 + 1.346_4			
(51)	Kainite Mg + S + O_2 + O_2 + K + Cl + $3H_2O$			
		2.113	2.067	D
			2.13	M
	55.966 = 0.4758(8.71 + 15.53 + 4.45_2 + 2.51_2 + 22.29 + 15.085 + 14.03_3)			
		1.4758	1.47	M
			1.494	S
	55.9635 = 6.0015 + 5.75 + 1.747_2 + 1.346_2 + 7.49 + 10.82 + 6.572_3			

	Theor. Column	Obs. Column	
(52) Gaylussite $Na_2 + Ca + C_2 + O_2 + O + O_3 + 5H_2O$	**1.954**	1.95	Bous
$66.869 = 0.4415(11.865_2 + 14.54 + 8_2 + 7.53_2 + 4.45 + 2.51_3 + 14.03_5)$	**1.4415**	1.444	S
$66.869 = 3.865_2 + 10.52 + 3.333_2 + 1.654_2 + 1.747 + 1.346_3 + 6.572_5$			
(53) Trona $Na_6 + C_4 + O_2 + O_9 + 5H_2O$	**2.14**	2.14	D
$84.8074 = 0.40195(11.865_6 + 8_4 + 7.53_2 + 2.51_9 + 14.03_5)$	**1.40195**	1.41	S
$84.804 = 3.865_6 + 3.333_4 + 1.654_2 + 1.346_9 + 6.572_5$			
(54) Epistilbite $Ca + Al_2 + Si_6 + O_6 + O_{10} + 5H_2O$	**2.18**	2.18	M
$140.243 = 0.50315(14.54 + 9.05_2 + 17.61_6 + 7.53_6 + 2.51_{10} + 14.03_5)$	**1.50315**	1.5	M
$140.244 = 10.52 + 7.865_2 + 9.625_6 + 1.654_6 + 1.346_{10} + 6.572_5$			
(55) Allophane $Al_2 + Si + O_3 + O_2 + 5H_2O$	**1.87**	1.85-1.89	D
$66.7057 = 0.49496(9.05_2 + 18.91 + 7.53_3 + 2.51_2 + 14.03_5)$	**1.49496**	1.49	M
$66.705 = 7.865_2 + 10.461 + 1.654_3 + 1.346_2 + 6.572_5$			
(56) Thaumasite $Ca_3 + Si + C + S + O_3 + O_7 + 15H_2O$	**1.880**	1.877	D
$165.125 = 0.4992(14.54_3 + 13.02 + 8 + 15.53 + 7.53_3 + 2.51_7 + 14.03_{15})$	**1.4992**	N_0 1.500	W
$165.137 = 10.52_3 + 11.53 + 3.333 + 5.75 + 1.654_3 + 1.346_7 + 6.572_{15}$			
(57) Mica (Muscovite) $H_2 + K + Al_3 + Si_3 + O + O_{11}$	**2.893**	2.855	Scha
		2.93	M
$82.114 = 0.5968(5.76_2 + 22.29 + 9.05_3 + 13.83_3 + 7.53 + 2.51_{11})$	**1.5968**	1.5977	D
$82.111 = 2.613_2 + 7.49 + 7.865_3 + 9.78_3 + 1.654 + 1.346_{11}$			
(58) Andalusite $Al_2 + Si + O_2 + O_3$	**3.107**	3.07	Schm
		3.12	Schm
$32.887 = 0.63075(9.05_2 + 17.61 + 4.45_2 + 2.51_3)$	**1.63075**	1.632	D
$32.887 = 7.865_2 + 9.625 + 1.747_2 + 1.346_3$			
(59) Gehlenite $Ca_3 + Al_2 + Si_2 + O_2 + O_2 + O_6$	**3.025**	3.01	D
		3.04	W
$87.414 = 0.6781(13.25_3 + 12.05_2 + 13.02_2 + 7.53_2 + 4.45_2 + 2.51_6)$	**1.6781**	1.67	M
$87.414 = 13.25_3 + 4.863_3 + 11.53_2 + 1.654_2 + 1.747_2\ 1.346_6$			
(60) Margarite $H_2 + Ca + Al_4 + Si_2 + O + O_{11}$	**3.012**	3.012	D
$84.688 = 0.6409(5.76_2 + 14.54 + 9.05_4 + 18.91_2 + 4.45 + 2.51_{11})$	**1.6409**	1.64-1.65	D
		N_m 1.643	Lars
$84.681 = 2.613_2 + 10.52 + 7.865_4 + 10.461_2 + 1.747 + 1.346_{11}$			

N_m = mean index of refraction R.V. = relative volume
N_0 = index of refraction for the ordinary ray O.R. = optical refractivity
H.F. = heat of formation

GREAT CHEMISTS AND THE DEVELOPMENT OF CHEMISTRY.

The lives of the outstanding contributors to Science have mostly been recorded in biographies or historical treatises. Many of these volumes are, however, still incomplete and the achievements of early experimentalists are probably still only partly known.

Dr. E. J. Holmyard continues to fill some of the lacunæ by his own searches and compilations and his latest work is a very readable and authoritative volume, *The Great Chemists* (1), in which he traces the history of Chemistry from antiquity to the present day. He points out that chemistry was not always a well-defined science with a coherent body of doctrine resting upon the solid basis of innumerable experimental facts. The farther back it is traced the more diffuse it becomes until at length it is lost in vague speculations and confused impiric technical knowledge. The germ of chemistry as a science lies in the attraction of gold which made it the standard of value in the world. Chemistry is largely the outcome of early efforts to prepare gold artificially. Early metallurgy in Egypt and elsewhere formed the practical basis of the science which was greatly developed by Jabir (Geber) and other Islamic scientists. Much new information is given concerning the life, works and achievements of Jabir, who flourished in the eighth century. He was acquainted with the usual chemical operations such as solution, crystallisation, calcination, reduction, sublimation, etc. The preparation of a number of substances is recorded in so clear a manner that his methods can be successfully repeated to-day. This is in marked contrast with the descriptions given by contemporaries and later alchemists.

Razi or Rhases (866-925) and Ibn Sina or Avicenna (980-1036) were two other outstanding early Islamic scientists who made contributions to chemistry. Razi was the first to classify chemical bodies into three groups, animal, vegetable and mineral. Of minerals he recognised six classes, spirits, bodies, stones, vitriols, boraces and salts. Ibn Sina is probably credited with more works than he is entitled to, but his treatise of natural philosophy, containing a chapter on chemistry, makes him worthy of a place among the great chemists.

Chemistry in England may be said to have begun with Roger Bacon (1214-1292) who has been credited with the discovery of gunpowder. Little more of marked progress was until the time of Robert Boyle, who, in his *Sceptical Chemist*, 1661, defined an element almost in the way accepted to-day.

In the meantime progress had been made on the continent through the teaching of Paracelsus. Then Stahl developed Becker's Phlogiston Theory, which stated that all combustible bodies contain within themselves a "principle," phlogiston, which leaves the body, on burning, as flame or light and heat. The body is thus composed of the residue (calx) plus phlogiston. Bodies rich in phlogiston, *e.g.*, charcoal, will leave little residue on burning. If heated with a calx, a body rich in phlogiston can add this principle to the calx converting it into a metal. This erroneous theory which took almost a century to disprove, was productive of many useful researches.

The end of the eighteenth century saw great changes. Discoveries were made by Priestley and Cavendish in England, Scheele in Sweden and others which Lavoisier in France, turned to account in overthrowing the views of Becker and Stahl and introducing the modern view concerning combustion by union with oxygen.

The contributions of Dalton, Sir Humphry Davy, Avogadro, and Berzelius; the growth of organic chemistry through the work of Liebig, Kekulé and Pasteur; the introduction of the periodic classification of the elements by Mendeléjev and the work in more physical branches by Arrhenius and Sir William Ramsay are carefully portrayed with an historical continuity. It will be seen that Dr. Holmyard has referred to the outstanding figures who have been instrumental in building up the science of chemistry whilst he has wisely refrained from giving too detailed descriptions of the more abstruse branches. His book may be cordially commended not only to chemists themselves but to other men of science and to the general public.

Messrs. Gauthier-Villiers have also published a volume on *The Chemistry of To-day and Yesterday*. Like Dr. Holmyard's, this one by Dr. Kirrmann traces the development of chemistry from early times to its modern period of specialised branches and sub-divisions. Both books emphasise the international character of science and both deal broadly with its growth through the ages. Dr. Kirrmann's volume is, however, the more detailed and he is concerned more with discoveries, facts, and theories than with personalities.

Early and Medieval Science is briefly indicated, whilst the author lays more emphasis upon the historical development of the various branches of chemistry—mineral, organic, analytical, synthetic and physical.

In each case attention is paid to the important advances made by individual scientists and short bibliographical notes are given at the end, together with a useful glossary of technical terms (in French).

Dr. Kirrmann's book is also a valuable addition to the historical literature of chemical science and can be strongly recommended to those readers who understand French.

J. G. F. DRUCE.

(1) *The Great Chemists.* By DR. E. J. HOLMYARD, M.A., Pp. vi + 188. London: Methuen & Co. 1928. Price 3s. 6d.

(2) *La Chimie d'Hier et d'Aujourd'hui.* Par DR. A. KIRRMANN. Pp. VIII + 148. 1928. Price 15 fr.

SAFEGUARDING OF KEY INDUSTRIES.

Representations have been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding dicyandiamide.

Section 10 (5) of the Finance Act, 1926, is as follows :—

"The Treasury may by order exempt from the duty imposed by section one of the *Safeguarding of Industries Act*, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any communications with respect to these representations should be addressed to the principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, London, S.W.1., within one month from the date of this notice.

Under the Order in Council dated 6 February, 1928, the Lord President of the Council has appointed Sir David Milne-Watson, LL.D., D.L., and Mr. Robert Whyte Reid, C.B.E., M.I.M.E., to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in the place of members who have retired on the completion of their terms of office.

The Lord President has also reappointed Sir James Hopwood Jeans, D.Sc., LL.D., Sec.R.S., to be a member of the Advisory Council for a further period of one year.

SOIL-CORROSION STUDIES.

By K. H. LOGAN, S. P. EWING, AND C. D. YEOMANS.

(*U. S. Bureau of Standards.*)

After a number of years of study of corrosion due to stray electric currents in the earth by the American Committee on Electrolysis and the Bureau of Standards, it became evident that in some cases the cause of observed corrosion could not be decided until it was known whether serious corrosion could occur in uncontaminated soil where no stray currents were present.

The Bureau of Standards, therefore, undertook to conduct an investigation of the relation of soils to the corrosion of buried pipe. The original investigation, planned to be of a practical nature and quite limited in its scope, has been amplified by the burial of additional materials and by laboratory investigations.

A very wide interest has been manifested in soil corrosion, and many questions have been raised which can not be answered by the data which are being obtained. The studies of soil corrosion were begun in 1922, and the field work has been so planned that specimens will be removed at about two-year intervals for a period of ten years. Of the specimens buried, about one-seventh have been removed for examination.

The work is therefore in its initial stage and will not be finished for several years. However, because of the interest manifested in the work and the plans for corrosion studies that other organisations are considering, it seems advisable to set forth in some detail the plans and scope of the bureau's investigation and to publish and discuss such data as are now available, as a result of the investigation. The data indicate that in certain regions soil corrosion is an active enemy of buried pipe lines, that the material best suited to resist the action of one soil is not necessarily the best for other soil conditions, and that the use of some form of a protective coating is desirable under a number of soil conditions.

Because the rates of corrosion so far observed may not continue, and because the rate for one material may change more than the rate for another, no conclusions can be drawn at this time as to the ultimate life of materials under test nor of the

relative merits of materials that are nearly alike. So far as observations on the materials are concerned, this report is therefore preliminary in its nature and will be followed by such others as the data secured later seem to justify.

BITUMINOUS COAL CONFERENCE.

Nearly fifteen eminent British scientists and engineers who are identified with the latest discoveries in the use of bituminous coal and its by-products are expected to address the Second International Conference of Bituminous Coal to be held at the Carnegie Institute of Technology in Pittsburg, November 19-24, 1928.

Although the final programme details have not yet been arranged by President Thomas S. Baker and his associates, representatives of England, it is announced, will participate promiuently in the discussions of the use of pulverised fuel, coal washing, low temperature distillation, liquefaction, boiler fuels, and other subjects listed for consideration.

Among the prominent British scientists who have already accepted invitations to present papers at the coming Coal Congress are Dr. R. Lessing, consulting engineer, on "The Rational Cleaning of Coal"; Dr. George E. K. Blythe, Buell Combustion Company, Ltd., on "Pulverised Fuel Conveying and Firing with Special Reference to Locomotives and Marine Boilers"; Harald Nielsen, Sensible Heat Distillation, Ltd., F. S. Sinnatt, assistant director of fuel research, Department of Scientific and Industrial Research, and Charles Turner, Glasgow, who will speak on phases of low temperature distillation; R. H. Crozier, manager, Mineral Oils Extraction, Ltd., who will read a paper on liquefaction; C. J. Goodwiu, consulting chemical engineer, who will speak on boiler fuels; Edgar C. Evans, National Federation of Iron and Steel Manufacturers; Dr. E. W. Smith, technical director, the Woodhall,Duckham Companies; Dr. C. H. Lander, director of fuel research, Department of Scientific and Industrial Research; J. Ivon Graham, director, Mining Research Laboratory, University of Birmingham; and Colonel Lindemann, the Anglo-Persian Oil Company.

Considerable interest is reported in the expected appearance of Lord Melchett as one of the speakers at the Coal Congress. Lord Melchett, it is expected will speak on

France, Germany, and Canada, it is announced, will have comparative large delegations of speakers among the eighteen foreign countries to be represented at the conference. Prominent Canadians who are expected to attend, either as speakers or as delegates, include A. E. Cameron, K. C. Gilbert, W. A. Lange, and Edgar Stansfield, University of Alberta; Charles Camsell, deputy-minister, Department of Mines, Ottawa; Dr. H. M. Tory, president, and F. E. Lathe, National Research Council; and A. T. Stuart, consulting engineer, Toronto. Other countries that will be represented by at least one speaker or delegate include Italy, Austria, Belgium, Chile, Cuba, Czecho-Slovakia, Denmark, Japan, Jugo-Slavia, Norway, Poland, Roumania, Russia, and Spain.

In all, more than one hundred of the leading fuel technologists, chemists, and engineers of the world will read papers at the meeting. In general, the subjects to be covered are "The Use of Pulverised Fuel for Power Production," "Origin of Coal," "Gas Production and its Relation to Power," "Liquefaction," "Tars and Oils," "Fixed Nitrogen," "Low Temperature Distillation," "Boiler Fuels," "Coal Washing," and miscellaneous topics concerned with improved utilisation of bituminous coal.

ON STUDIES OF IMPROVING ESTIMATION METHODS OF IMPURITIES IN THE CRUDE CAMPHOR III. DETERMINATION OF OIL CONTENT.

By SEIICHI YAMADA AND TERUJI KOSHITAKA.
(Abstracted from the Journal of the Society of Chemical Industry, Japan.)

Oil content in the crude camphor has been sometimes undertaken by estimating it with the iodine value (K. W. Lane, *Jour. Soc. Chem. Ind.*, 1922, XLI, 32 T; *Perf. & Ess. Oil Rec.*, 1922, XIII, 81; K. Kafuku, *Report of Ind. Depart. of Central Institute of Formosa*, No. 4, 13). The authors obtained the hopeful results on measuring it by the iodine value (of Rosenmund's method) determined under the following conditions studied already (*Jour. Soc. Chem. Ind.*, 1928, XXXI, 141 B). One gram of the crude camphor is dissolved in 5 cc. of carbon tetrachloride, to which 20 cc. of $N/5$ bromine solution are added. After standing at 20° C. for 10 minutes, 20 cc. of 10 per cent. potassium iodide solution are instantly run in and the whole is titrated with $N/10$ thiosulphate solution after diluted 100 cc. of water.

When the oil content is above 2 per cent. and the halogen excess percentage shows below 90, the amount of the sample is suitably reduced or the bromine solution is increased so much that the percentage rises to 90, on the contrary in the case the oil content is less than 1 per cent., 10 cc. of $N/5$ or 20 cc. of $N/10$ bromnie solution are used. But a quantity of oil below 0.1 per cent. is hardly measured.

Then the determination of oil in the camphor of 3 classes, B, B. B, and the refined, was carried out by the above method obtaining the results that B. contained about 2 per cent. of oil, B. B, 0.6 per cent., and the refined 0.06 per cent.

A WARNING.

The Registrar of the Institute of Chemistry is informed that chemists in Birmingham and district have lately been receiving visits from a man impersonating a professional chemist resident in the Manchester district. This person, who is seeking financial assistance, pretends that he has appealed to the Benevolent Fund of the Institute and is awaiting the decision of the Committee. He is an impostor, and should be given in charge.

GENERAL NOTES.

NICKEL AND PLATINUM DISCOVERIES.

The Winnipeg correspondent of the *Financial Post* (Toronto), states in the September 21 issue of that Journal that a new discovery is reported in the Rotten Lake district of Saskatchewan, west of Reindeer Lake, of a huge outcrop of nickel-platinum ores, with a dome 16 feet wide and 100 feet long, rising 40 feet in the air.

According to the journal mentioned, samples brought out from the discovery assay five per cent. nickel, which is one per cent. higher than that of the Creighton, the high-grade deposit of the Sudbury area, and just about twice the average of the Sudbury Camp. In addition there are platinum values, as is the case with Sudbury. It is understood that one assay showed a trace of platinum. One large sample is said to have given combined values of $100 per ton with $80 in platinum. Platinum assays are difficult, however, because of the minuteness of the content and the necessity of having a substantial amount of ore to get a real assay for this metal.

CANADA'S OUTPUT OF COBALT, 1927.

Finally revised statistics on Canada's cobalt production show the output of this metal in 1927 at 880,590 pounds, valued at $1,764,534, as against 664,778 pounds valued at $1,130,014 in 1926. This production figure includes the cobalt content of the various cobalt products sold by the Deloro Smelting and Refining Company, Limited, which company treats the greater portion of the silver-cobalt ores of Ontario, and the cobalt content of the ores and residues exported for treatment in foreign smelters; the value given is the net amount received by the shippers. Canada produces about 55 per cent. of the world's supply of cobalt, which is sold in the form of oxide for use as a pigment in the manufacture of earthenware, porcelain and enamelware. The addition of cobalt oxide produces the well-known "cobalt-blue" colour; it is used in other forms as a drier in paints and varnishes.

Cobalt metal is chiefly used in the manufacture of stellite, a cobalt-chromium-tungsten alloy used in making cutting tools for high speed lathe work. Cobalt is also an important ingredient of certain stainless steels used for cutlery and surgical instruments.

FERTILISER MANUFACTURE IN BRITISH COLUMBIA.

A 35-ton sulphuric acid plant, now being erected at Trail, British Columbia, by the Consolidated Mining and Smelting Company of Canada, is an indication of progress in two directions, the one being the further reduction of the chemical content of the smelter fumes, and the other preparation for the expected manufacture of superphosphate fertiliser. The Company's first sulphuric acid plant, erected in 1916, makes its first product by burning pyrite ore. The new sulphuric acid plant, which will be in production by the end of this year, will turn out 35 tons daily of 100 per cent. acid, utilising sulphur dioxide fumes in the zinc refinery.

The Company's engineers have discovered very large beds of phosphate rock in the vicinity of Fernie, British Columbia, and this year triple phosphate fertiliser has been despatched from the Tadanac plant to points in the Prairie Provinces, where tests have been made by farmers.

If a demand should be created for fertiliser produced at the plant, it is contemplated that the tailings at Kimberley will be used as the basis of a larger supply of sulphuric ... ianufacturing superphosphate.

TALC AND SOAPSTONE, 1927.

Talc and soapstone production in Canada during 1927 amounted to 16,521 tons valued at $236,105, according to finally revised statistics just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa. In 1926 shipments were recorded at 15,767 tons worth $217,195.

Ontario's production was made up of talc obtained from deposits near Madoc, Hastings county, and soapstone from the Grace mine near Vermilion Bay. Quebec shipments were from quarries in Broughton, Leeds and Thetford townships and consisted principally of soapstone blocks for use in lining the alkali recovery furnaces of sulphate (kraft) pulp mills. Small shipments of talc were made from two deposits in British Columbia, one located on Vancouver Island and the other near Wilmer, Windermere mining division.

Talc or soapstone, ground or unground, imported into Canada during 1927 amounted to 4,907 tons appraised at $86,858. Exports of refined talc totalled 10,692 tons worth $125,123.

Capital employed by the six firms operating in the talc and soapstone industry was recorded at $715,439. Employment was furnished 18 salaried employees and 109 wage-earners; their total earnings were $87,721. Fuel and electricity used during the year accounted for an expenditure of $25,169.

TOBACCO IN CZECHOSLOVAKIA.

Tobacco is grown in Czechoslovakia only in the southern parts of Slovakia and Ruthenia (Podkarpatská Rus). The total tobacco consumption in Czechoslovakia amounts to almost 200 thousand quintals per annum, of which only 70,000 quintals are home grown. The Czechoslovak Tobacco Control pays over to inland cultivators the sum of 40 million crowns and to foreign growers about ten times that sum. The Ministry of Agriculture and the Agricultural Council in Bratislava are collaborating to take steps to effect the improvement and the increase of tobacco production. A special Tobacco Commission has been set up with thie end in view by the Agricultural Council in Bratislava.

CANADIAN GOLD PRODUCTION FIRST HALF-YEAR.

During the six months ended June 30 last Canada produced 906,258 fine ounces of gold valued at $18,734,011 as compared with 863,031 fine ounces worth $17,840,484 for the corresponding period of 1927, an increase of approximately 5 per cent.

During the six months Ontario contributed to the total a production of 778,289 fine ounces valued at $15,981,302; the remainder being attributed to British Columbia (95,588 fine ounces worth $520,475). The Yukon Territory (5,934 fine ounces, worth $122,667), Manitoba (5,125 fine ounces, worth $105,943), followed by Nova Scotia (1,144 fine ounces worth $23,649).

CANADIAN SMELTING OPERATIONS.

According to a statement just issued by the Dominion Bureau of Statistics at Ottawa, smelting operations on non-ferrous ores in Canada last year represented a total addition to their value calculated at $35,479,578. This figure compares with $33,615,909 in 1922, showing an increase of 35 per cent., or $11,863,669.

Though the value of many of the products, notably silver, lead, zinc and copper, was lower than in the previous year, the total value of smelter products was $5,142,699 higher at $77,996,265, this figure comparing with $72,853,566 in 1926. The estimated cost of ores treated was $32,516,617 in 1927 as against $39,237,657 in 1926.

The importance of the smelting and refining industry to Canada, and the rapidity with which it is growing, are indicated by the statistics on capital employed, number of employees and pay-roll. The capital investment in the 10 plants engaged in 1927 in the smelting and refining of non-ferrous ores was $81,779,240. Particularly striking is the increase in the pay-list last year as compared with the previous year. In 1927 there were 7,671 salaried employees and wage earners, an increase of 1,445 over the 6,226 employees in the industry in 1926. Salaries and wages in 1927 totalled $12,120,240 as against $9,584,938 in 1926.

Fuel and electricity used in the industry in 1927 amounted to $6,380,127, including coke, $2,166,276; electricity, $2,655,634; bituminous coal, $1,035,840 ! and fuel oil, $426,123. Power employed totalled 172,182 horse power, of which 64,485 h.p. was supplied by hydraulic turbines and water wheels and 94,859 h.p. by electric motors operated on purchased power.

The non-ferrous smelting and refining industry includes the smelting and refining of Canadian cobalt-silver, nickel-copper, copper-gold-silver, silver-lead-zinc and lead ores as well as the production of aluminium from imported raw material.

NICKEL PRODUCTION.

During the first half of 1928 Canada produced 46,463,107 lbs. of nickel worth $10,625,702, as compared with the corresponding 1927 total of 34,781,199 lbs. valued at $8,008,823, an increase of 33.6 per cent. in quantity and of 32.7 per cent. in value. The total production was made up of 19,589,969 lbs. of nickel in matt and speiss exported; 21,955,829 lbs. representing refined and electrolytic nickel produced in Canada; and 4,917,309 lbs. of nickel in oxides and salts sold.

According to figures just published by the Dominion Bureau of Statistics at Ottawa, Canadian exports of nickel in August reached 8,007,200 lbs., valued at $1,818,327, as compared with 3,268,300 lbs. with a valuation of $907,145 in August, 1927. These figures include exports of nickel in ore or matte, in oxide, and refined. In exports of this metal, in which Canada supplies upwards of 90 per cent. of the world's requirements, the value has been consistently higher in each month of 1928 than in the corresponding month of last year. The eight months' total to the end of August stands at 65,312,200 pounds compared with 42,973,800 pounds in the corresponding period of last year. The export valuation for the first eight months of 1928 was $14,463,647, representing a gain of $5,018,726, or 53 per cent. more than the export valuation for the similar period of 1927.

OVERSEAS TRADE.

H.M. Acting Commercial Secretary at Santiago reports that the Chilean State Railways are inviting tenders for the supply of the following :—

120 to 166 metric tons of Carbide of Calcium. Closing date, 25 October, 1928.

Spare parts and fittings for locomotives, carriages and waggons, including tyres, axles, weldless steel tubes for boilers, springs, etc. (Group Nos. 37 and 38 of Chilean State Railway Administration's annual requirements). Closing date, 5 December, 1928.

Tenders will be opened at 3 p.m., on the dates indicated at the Stores Department, Alameda Station, Santiago.

Local representation is essential, and this Department will be pleased to furnish British firms desirous of tendering and not represented in Chile with the names of firms who may be prepared to handle tenders on their behalf.

A copy (in Spanish) of the specifications, together with details as to marking, form of quoting, etc., can be seen at this Department (Room 30) Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., or a spare copy of these documents will be forwarded on loan, in order of application, to interested firms in the provinces who may be unable to arrange for their inspection in London.

It is regretted that owing to the short time allowed for tendering in the case of the requirements of carbide of calcium earlier notification has not been possible, but firms desirous of submitting an offer may be able to cable instructions to their local agents.

POST OFFICE CONTRACTS.

The following letter has been sent to the Postmaster-General by the Federation of British Industries :—

"Sir,—As Chairman of the Non-Ferrous Metals Group of the Federation, I have been asked by those of our members interested in the manufacture of Telephone Bronze Wire to address you, regarding the placing of contracts for this material with French and German factories.

The intimation that their tenders had been declined, and that orders were to be placed abroad—causing, of course, additional unemployment — was received by British manufacturers of bronze wire simultaneously with an appeal from the Prime Minister to attempt to absorb labour from the distressed areas.

Our members recognise that it is somewhat outside their province, as manufacturers, to criticise the policy of the Government of placing work abroad when there is so much unemployment at home, but estimates have been put before me, from which it would appear that any saving to the Department in the price of wire will at least be offset by the extra amount to be found by the country in unemployment pay.

What gravely concerns the manufacturers, however, is the effect caused by the example set by the Post Office, and by the incorrect and misleading statements issued in explanation of their action, as published in the *Times* of August 25, and September 25, which unless contradicted or withdrawn, will seriously damage British Industry, causing still further unemployment. In fact, the damage already done cannot entirely be repaired, as is abundantly evident

from the correspondence which the manufacturers are receiving from Municipal Corporations and other buyers, at home and abroad.

These statements amount to a charge that British maunfacturers of this material have united to obtain excessive prices from the Department, and have refused to accept contracts when offered to them at ' reasonable ' prices.

The manufacturers claim that their prices are unreasonably low, rather than high, and that it is unfair to compare them with those of products of manufacturers in the countries where the costs of labour and taxation are considerably lower than in Great Britain.

In the Post Office statement given to the Press, a reference is made to the recommendation of the Select Committee on Estimates, to the effect that the Post Office should have a free hand to accept tenders from abroad in cases where it is unable to obtain satisfactory evidence that the prices quoted by British manufacturers are not excessive. In the present case, the Officers of your Department have been afforded full information, and the tenderers understood that they were satisfied that, under the circumstances of costs obtaining in this country on the limited requirements of the Post Office, the prices are not excessive, and carry little or no profit to the manufacturers.

In confirmation of this, I may state that I have seen a certificate furnished by a firm of chartered accountants to the effect that the price tendered would provide a gross profit of less than 8½ per cent., which would be more than absorbed by standing charges.

The Post Office have, in the past, treated as evidence that British prices are excessive the fact that, at one time, lower prices were quoted abroad. This was done in order that, with this department of the works full, more labour would be employed and the cost in the home market reduced. The Post Office were well aware of the circumstances, and received the benefit of the reduction in cost; they are also aware that, for some time past, it has not been in operation.

I trust, therefore, you will be willing to make further enquiries into this matter. The manufacturers, on their side, are confident that the results of your investigations will satisfy you that steps should be taken to remedy, as far as possible, the injustice which has been done to them.

In view of the publicity which has already been given to the matter, I am sending a copy of this letter to the Press.

I am, Sir,
Your obedient servant,
(Sgd.) THOMAS BOLTON,
Chairman.

The Rt. Hon. Sir William
Mitchell-Thomson, Bt., M.P.,
Post Office,
St. Martin's le Grand, E.C.1."

Proceedings and Notices of Societies

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting held on Tuesday, October 9, 1928 : *The Analysis of Cracked Spirits. The Determination of Aromatic, Olefine Naphthene and Paraffin Hydrocarbons.* By F. H. GARDNER, Ph.D., M.Sc., F.I.C.

The importance of cracking to supplement the natural spirit present in crude petroleums is well recognised at the present time, and in view of the anti-pinking qualities of these spirits, in some instances cracked spirits are sold at a premium over straight-run spirits.

Analysis of such spirits has been a matter of considerable difficulty, because there is no satisfactory method of separating olefines from aromatic hydrocarbons.

The question of the relative values of the various types of hydrocarbons—aromatic, olefine, naphthene and paraffin—has aroused considerable interest of late because of the increased power obtainable from the internal combustion engine if the compression ratio can be satisfactorily increased. A survey of the subject has been made by Ricardo, who has tested on his variable compression ratio engine several gasolines, three normal paraffins, three aromatic hydrocarbons and two of the cyclohexane hydrocarbons in fairly pure condition. As a large proportion of the naphthenes in gasolines is composed of cyclopentane hydrocarbons, we have no satisfactory value for this group of hydrocarbons. Dr. Edgar has shown that a branched chain octane, 2.2.4-trimethyloctane, possesses anti-knocking qualities of approximately the same order as toluene, whereas normal octane is of a knock-inducing character. Similar branched chain paraffin hydrocarbons have been found in straight-run gasolines, and it is obvious that further work must be done before any satisfactory value can be ascribed to the paraffin

hydrocarbon content of gasolines. It it possible that in one gasoline, normal hydrocarbons may predominate whilst another another gasoline may consist almost entirely of branched chain hydrocarbons, but the evidence available points to a general similarity in the composition of all natural gasolines.

If we had a satisfactory method of analysing petroleum spirits for paraffin and naphthene hydrocarbons, then it should be possible definitely to settle this question by determining the highest useful compression ratio or knocking values for a number of gasolines and ascertaining the knocking values of the paraffin, naphthene and aromatic hydrocarbons from the percentages of these hydrocarbons present.

Sulphuric acid does not effect a satisfactory separation of the olefines and aromatic hydrocarbons present in cracked spirit, as in addition to the polymerisation of olefines, condensation of olefines and aromatic hydrocarbons also occurs. A method of analysis has been devised which given results with a fair degree of accuracy.

It appears probable that branched chain olefines are present in fairly large proportions in cracked spirits as would be exected in view of the fact that the material cracked is composed mainly of branched chain and cyclic hydrocarbons.

Olefine and aromatic hydrocarbons are removed simultaneously from the cracked gasoline with nitric acid, and the aniline point of the remaining spirit is used for the estimation of the percentage of paraffin and naphthene hydrocarbons.

The aniline point difference before and after the acid treatment is determined, and also the percentage loss in volume.

The iodine number of the original petrol is found.

The Action of Sulphuric Acid on Cracked Spirit.

Aromatic hydrocarbons behave as though they were slightly unsaturated and olefines vary considerably in their reactiveness, and so far no reagent has been discovered that will completely remove olefines without at the same time removing also at least part of the aromatic hydrocarbons present.

The low reactivity of the higher olefines, and the instability of the addition compounds which they form, render the separation of olefines from aromatic hydrocarbons very difficult. Sulphuric acid has been used for the estimation of olefines in cracked spirit although it is recognised that [illegible] treated oil contains polymers

so that the actual olefine content is higher than that measured by loss in volume. Attempts have been made to determine the proportion of polymers by distillation to a lower end-point than that of cracked spirit.

Even with 98-100 per cent. sulphuric acid, as used in the Institution of Petroleum Technologists Standard Method for the estimation of aromatic hydrocarbons, the treated portion of a cracked spirit does not correspond with the paraffin and naphthene content of the spirit; removal of the olefines and aromatic hydrocarbons and *their reaction products* is not completely effected even with this concentration of acid. It is known that more highly concentrated acid will attack the naphthenes present in gasolines.

If various percentages of pure aromatic hydrocarbons are added to a cracked gasoline, and the olefinic and aromatic hydrocarbons simultaneously removed from these mixtures by suitable treatment, then if no side reactions have occurred the specific gravity and aniline points of the treated portion should be the same from all the mixtures.

The fuming nitric acid treatment gives gasolines with substantially the same specific gravities and aniline points for all three spirits, so that these figures may be assumed to correspond with the paraffin and naphthene hydrocarbon content of the original petrol.

With sulphuric acid two reactions occur:

(1) Polymerisation, giving products of higher specific gravity and aniline point than the original spirit.

(2) Condensation of olefines and aromatic hydrocarbons to give products of higher specific gravity and aniline point than the original spirit.

The products of these reactions are not completely removed by the sulphuric acid treatment, with the result that the specific gravity of the acid-treated spirit is always higher than that of the paraffin and naphthene portion of the cracked spirit, but the aniline point is sometimes higher and sometimes lower after the treatment, depending whether the aromatic hydrocarbon content is high or low.

There are thus two fundamental sources of errors in the sulphuric acid method for the analysis of cracked spirits:—

(1) Olefines and aromatic hydrocarbons are removed and simultaneously addition products formed, so that the loss in volume does not give a true indication of the olefine and aromatic hydrocarbon content.

(2) The treated portion of the cracked spirit is not the same as the paraffin and

naphthene portion of the cracked spirit; with the result that the properties of this acid-treated spirit cannot be used for the estimation of the paraffin and naphthene contents.

Fuming Nitric Acid and Cracked Gasoline.

It is not possible to duplicate a cracked gasoline by making a mixture of synthetic hydrcarbons of the different series owing to the large number of individual hydrocarbons which would be necessary. It was decided to make a nearly aromatic-free gasoline by cracking a paraffin base crude petroleum and adding to it various proportions of aromatic hydrocarbons.

Hardstoft crude petroleum was, therefore, suitable for this purpose. The crude was cracked at a relatively low pressure and the resulting cracked distillate refined to give a gasoline with 30 per cent. over at 100° C. and 185° C. end-point. To this refined gasoline of iodine number 120, aromatic free gasoline of similar distillation range was added, and gasolines of iodine numbers 74 and 48 were obtained with, of course, much lower aromatic hydrocarbon content. By analysis, 0 and 1.5 per cent. of aromatic hydrocarbons were found in these mixtures.

Attempts have been made to utilise the nitro-compounds, formed by the nitric acid treatment, for the estimation of the aromatic hydrocarbons. As the olefines form addition compound with the nitric acid, and these give a certain proportion of solid tri-nitro-compounds which are not readily distinguishable from those derived from aromatic hydrocarbons. The stability of these nitro-compounds was much greater than expected.

The method of analysis described in the preceding pages is not claimed to be as accurate as could be desired; for example, the percentages of paraffins and naphthenes cannot be determined accurately without a very complicated procedure. It is, however, put forward as a rational method of analysis which will give consistent results with an accuracy probably within 1 of the correct figure. This accuracy is sufficient for correlating with engine tests or for estimating the approximate value of a fuel from anti-pinking qualities.

SOCIETY OF PUBLIC ANALYSTS.

An Ordinary Meeting of the Society was held in the Chemical Society's Rooms, Burlington House, on Wednesday, October 3, the President, Mr. Edward Hinks, being in the chair.

Certificates were read for the first time in favour of Charles Wesley Bayley, Harry Brindle, B.Sc., A.I.C., William George Burgess, Albert Clarke, George Leonard Clothier, Hector Ingram Downes, M.Sc., A.I.C., Alec Walter Greenhill, M.Sc., A.R.C.Sc., A.I.C., D.I.C., Donald R. Hayward, B.Sc., B. L. Khuller, M.Sc., A.I.C., James Donald Kidd, B.A., M.Sc., A.I.C., Herbert Drake Law, D.Sc., F.I.C., Sidney John Saint, B.Sc., A.I.C.

Certificates were read for the second time in favour of: Bhagwat Prasad Bhargava, B.Sc., Cyril Ernest Gill and Thomas Percy Hilditch, D.Sc., F.I.C.

The following were elected Members of the Society: Arthur Duncan Gay, John Gordon Mayne, Reginald Arthur McNicol, M.Sc., A.I.C., William Ramsden Orrell, B.Sc., A.I.C.; Laurence Frederick Smith, M.Sc., A.R.C.S., A.I.C., D.I.C., Charles Frederick Turner, F.I.C.

The following papers were read and discussed:—

Polarimetric Determination of Sucrose in Milk and Sucrose Mixtures. By G. W. Monier-Williams, M.A., Ph.D., F.I.C.

A method has been based on the work of Jackson and Gillis and on the observations of Vosburgh and of Zerban, on the effects of concentration and temperature on the specific rotation of invert sugar. Angular rotation is used as being more suitable for general work that the saccharimetric notation commonly used by sugar chemists. The application of a correction for the volume occupied by proteins and fat is avoided by determining the total water present in the diluted mixture of milk and sucrose, defecating with dry reagents, and subsequently determining the ratio of sucrose to water in the clear filtrate. A device for maintaining a constant temperature in a polarimeter is described.

The Analysis of Starch Sugar Degradation Products by Selective Fermentation. By T. McLachlan, F.I.C.

After a critical study of the methods recommended for the analysis of such products as malt extract or glucose, the author has found the method of selective fermentation by different yeasts to be the most satisfactory. The yeasts used for the analysis are *S. Frohberg*, *S. Saaz*, and *S. Exiguus*; the difference between the total solids of the blank and the solution fermented by *S. exiguus* gives the amount of dextrose and laevulose; the difference in total solids in the solutions fermented by *S. exiguus* and *S. Frohberg* represents maltose; whilst the difference between the total solids after fer-

mentation by *S. Frohberg* and *S. Saaz* gives other fermentable sugars. The amount of dextrins is calculated from the optical rotation. Analyses of samples of commercial glucose and commercial malt extracts are given.

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates. XIII. A New Method for the Separation of Zirconium and Hafnium from Tantalum and Niobium. By W. R. SCHOELLER AND E. F. WATERHOUSE. (Work done under the Analytical Investigation Scheme).

A new method is described for the separation of small quantities of earth acids from large amounts of zirconia (hafnia). The process is based on the precipitation of the oxalo-earth acids by tannin in weakly acid solution, zirconyl oxalate remaining dissolved. The method described in an earlier Section—fusion of the mixed oxides with potassium carbonate— has been perfected, with the result that a single fusion may be sufficient for the separation of the bulk of the earth acids. The balance is then separated from the zirconium residue by the tannin procedure. The latter is a delicate test for the detection of the smallest quantities of earth acids in zirconia.

NOTICES OF BOOKS.

The Viscosity of Liquids. By E. HATSCHEK, F.I.C. Pp. XII + 240. London: G. Bell & Son, Ltd. 1928. Price 15s.

The growth of colloid chemistry has indicated that the subject of the viscosity of liquids is still imperfectly understood and presents special difficulties to students. Mr. Hatschek has therefore written a book dealing with the fundamental principles and recent practical knowledge that has accumulated in the last two decades during the development of our knowledge of disperse systems. The book is essentially practical and although mathematical expressions have been invoked to explain various phenomena, they are not beyond the grasp of students.

Abhandlungen aus dem Gesamtgebiete der Hygiene. (Dr. Grassberger). Vol 2.

(1) *Uber die Grundlagen der Beurteilung von Milchverfälschungen.* By ERNST KROMBHOLZ.

(2) *Uber die Schwierigkeiten bei der gerichtleichen Verfolgering von Lebensmittelverfälschungen und insbesondere von Milchverfalschungen.* By VLADIMIR FIKEIS.

Pp. VI + 88. Leipzig and Vienna: Franz Deuticke. 1928. Price 6m.

This monograph dealing with the adulteration of foodstuffs, particularly milk, will be of special interest to analytical chemists.

Modern Building Construction. Series No. 1.

"Standard Practice for the Manufacture of Concrete Blocks," as its title denotes, is a most useful text book dealing with this subject. The particulars given are based entirely on positive technical and practical experience and its 12 pages are well worth the study of those interested in building projects. The book is presented for the purpose of promoting the manufacture of concrete blocks of the very highest quality. The notes are a compilation of the processes and methods followed in various block factories, briefly described, so that if desirable they may be adapted to the needs of any blockmaking plant. "Standard Practice for the Manufacture of Concrete Blocks" may be obtained free of charge on application to the Portland Cement Selling and Distributing Co., Ltd., 20, Buckingham Gate, London, S.W.1.

The Chilean Review, a quarterly dealing with the economic and commercial matters, contains an interesting article on Iodine which is a by-product of the nitrate industry. The mother liquors from the crystallisation of sodium nitrate contain small amounts of sodium iodate which is treated with acid sodium sulphite to precipitate ("cut") free iodine. The original salt, or caliche, contains .06 per cent. of iodine, *i.e.*, 600 grams per ton. It is, however, impossible to extract more than about 20 per cent. of this because some of the iodine is lost by volatilisation during the precipitation process and subsequent filtration. Chile thus produces about 1,500 tons of iodine annually.

The carbonising of coal by low temperature processes is destined to bring many changes and developments with it. The smokeless fuel obtained by this distillation of powdered coal is already being adopted in many quarters. The industry has advanced so far that it is to have a journal of its own. *The New Coal Age* will be a monthly devoted to the interests of this new industrial branch of applied science.

Forthcoming Events.

THE INSTITUTION OF MINING ENGINEERS.

The thirty-ninth Annual General Meeting will be held, by kind permission, at the Rooms of the Geological Society, Burlington House, Piccadilly, London, W.1., on October 24 and 25.

The following papers will be submitted for discussion :—

" Atmospheric Conditions in Indian Coal-Mines " (Fifteenth Report of the Institution Committee on The Control of Atmospheric Conditions in Hot and Deep Mines). By David Penman, D.Sc. (Edin.), B.Sc. (Lond.), F.R.S.E.

" The Light Given by Various Types of Miners' Lamps." By Charles C. Reid and Albert V. Reis.

" The Sizing of Coal for Briquetting." By J. R. Homer, B.Sc.

If time permits, the following Papers, which have already appeared in the *Transactions*, will be further discussed :—

" Extracts and Recommendations from the Report of the Water Dangers Committee." By T. Greenland Davies, H.M. Divisional Inspector of Mines (*Trans. Inst. Min. E.*, vol. LXXV, p. 392).

" Mine Rescue Work in the United States." By George S. Rice, Chief Mining Engineer, U.S.A. Bureau of Mines (*Trans. Inst. Min. E.*, vol. LXXV, p. 426).

PUBLICATIONS RECEIVED.

U.S. BUREAU OF STANDARDS.

Classification of Iron and Steel Scrap. 10 c.

Malleable Foundry Refractories. 10 c.

Roofing Ternes. 10 c.

Turnbuckles. 10 c.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

27,790.—Gibson, W.—Manufacture of triaryl phosphates. September 27th.

27,758.—Gluckmann, E.—Production of

27,627.—I. G. Farbenindustrie Akt.-Ges. —Production of condensation products from benzoquinones. September 26th.

27,528.—Meissner, J., and Schmid, A.—Denitrating residuary acids. September 25th.

27,427.—Thorssell, T. — Production of nitrogen and hydrogen. September 24th.

Specifications Published.

297,546.—I. G. Farbenindustrie Akt.-Ges. —Process for the manufacture and production of alkali metal or ammonium phosphates.

292,966.—Muller, H. A.—Ethyl chloride tubes.

285,877.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of 4-nitro-2-amino-1-benzoic acid.

288,612.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of sulphonic acids derived from non-aromatic carboxylic acids.

297,665.—I. G. Farbenindustrie Akt.-Ges. — Alloys resistant to chemical action.

Abstract Published.

295,237.—Dyes. — I. G. Farbenindustrie Akt.-Ges., Frankfort - on - Main, Germany.

Monoazo dyes yielding bluish-violet to blue shades on acetate silk are obtained by coupling diazotised picramide or its homologues with a sulphonic acid of a N-aralkyl-, or N-alkyl aralkylaniline or a homologue or substitution product thereof. In an example picramide is diazotised by nitrosylsulphuric acid and coupled with N-ethyl-N-sulphobenzyl-3-toluidine; the produce dyes acetate silk in a neutral Glauber-salt or an acetic acid bath marine blue shades fast to washing and light, and dyes wool in an acid bath bluish-black shades. Other coupling components specified are N-methyl-N-sulphobenzylaniline, N-sulphobenzyl-2-toluidine, and N-benzylaniline-2-sulphonic acid. 3-Methyl-picramide is also specified as diazo component. Specifications 6197/94 and **220,303** are referred to.

N-ethyl-N-sulphobenzyl-3-toluidine, N-methyl-N-sulphobenzylaniline, and N-sulphobenzyl-2-toluidine are obtained by direct

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

KRASNODIN.

494,184.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. September 19th.

CELAMON.

494,183.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. September 20th.

GLEE.

493,996.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—J. Bibby & Sons, Limited, Bibby's Buildings, 21, *King Edward Street, Liverpool. September 26th.*

SNOWDROP.

493,110.—All goods in class 1 which includes acids, potash, salts, and other chemical substances used in manufactures.—Titanuite, Limited, Aldwych House, Aldwych, London, W.C.2. September 26th.

REGESAN.

489,461.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. October 3rd.

CHEMIST REQUIRED.

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PATENT LICENCES.

The Owners of Patent No. 222461 relating to

"Apparatus for the Synthetic Production of Ammonia and Its Elements,"

are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. Lloyd Wise & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

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ON DRYING OF SOME DAMMAR OIL VARNISHES.

By PROF. C. K. KRAUZ AND DR. V. F. HRACH.

Although extensive, the literature of varnishes contains very few data clearing up the chemical mechanism of drying of oil varnishes. Some elucidation of these complicated processes, which used to be denoted as "polymerisation," has been given by Fahrion, Wolff and many other authors, who studied, however, mainly the drying of linseed oil alone while—as may be seen from the literature—no one described such phenomena for the case of oil varnishes. But, nevertheless, one must suppose that already many practitioners tried to solve these problems with success, for otherwise it would be certainly difficult to comprehend the fact that one factory is able to prepare an excellent varnish from the same raw material from which another one is not able to do so at all. And that the factories are not willing to publish their experiences, very expensively acquired, is very understandable.

Trying to contribute to the solution of these complicated questions, and to acquire the data useful for the technical practice the authors examined systematically mixtures of dammar resin with some drying oils, *i.e.*, linseed, hempseed, locustseed (from Robinia Pseudoacacia), soya bean, poppyseed, and walnut oil. The varnishes were prepared by mixing equal parts of drying oil and pulverised dammar with an addition of weighed off quantities of metallic oxides as driers, and by heating the mixtures for a certain tim e to a temperature strictly limited. As driers, the following were examined: lead monoxide (PbO), dioxide (PbO_2) and minium (Pb_3O_4), cobaltous and cobaltic oxides (CoO and Co_2O_3), and manganous oxide (MnO). The cooled mixtures were diluted in all cases with the same amount, *i.e.*, 40 per cent. turpentine, let stand for 24 hours, and then analysed. For the examining of chemical changes occurred in varnishes thus prepared, acid, saponification and iodine values of the varnishes and of the raw materials were determined. From the amounts of the components applied for the mixtures given theoretical values were calculated and compared with numbers obtained by analytical determinations. As criterion for judging the quality of the varnishes prepared, their rapidity of drying was used, and the procedure of experiment was as follows: 30 parts of drying oil were mixed with 30 parts of pulverised dammar resin, added 1 part of metallic oxide (*i.e.*, 1 per cent. for the final varnish), and heated on a metal-bath in a small boiling flask closed by a cork bearing a long condenser and thermometer for 1 hour to a temperature strictly limited. In this way the optimal temperature was determined. By the next series of experiments, whereby the times of heating were changed, the optimal time of heating was pointed out, and in heating the same mixture for the optimal time and to the optimal temperature with different quantities of driers added the final optimum was found out. The total number

of all experiments carried out systematically was 410. With regard to such great number of experiments it certainly was not possible to give here all results obtained and thus one was obliged to confine them only in some diagrams and tables.

In comparing all these results one may notice that the most fluctuating values are the rapidities of drying. Excluding some cases of walnut oil varnishes, where times of drying longer than many months were observed, this value is fluctuating in limits from 50 minutes to 38 days, and depends not only on the kind and nature of the oil applied, but also on the degree of temperature and its time of action, and on the kind and quantity of the driers added.

An interesting phenomenon observed was the consistency of the varnishes prepared. There are regularly formed varnishes that are the thinner the higher the temperature applied. Thereby also a remarkable influence of the kind of driers could be noticed, as for instance, Co_2O_3 always produced at the same temperatures varnishes considerably thinner than other oxides, while CoO, under the same conditions, gave the thickest mixtures of all. This phenomenon can successfully be applied for determining the temperature necessary for a varnish optimally drying, as for instance, when an addition of Co_2O_3 leads to a sufficiently thin mixture at 175° C. it is the best sign of too much heating it still higher; for the rest, it is not even desirable for such " overheated " varnishes get usually a dark colour and dry considerably slower. Varnishes prepared with CoO at lower temperatures are regularly very thick—a sign that their optima must be sought at higher temperatures.

Another interesting result pointed out is the fact that the same kind of drier requires regularly either the same or very near optimal temperatures for different oils. Thus, for instance, in the case of linseed oil varnishes and of CoO as drier, the optimal temperature of 250° C. was found ,while other oils show the same degree. This interesting accordance was experimentally ratified in all cases in limits of maximally ±250° C., and only in the case of poppyseed oil and minium as drier was the observed difference 75° C.

To facilitate the comparison of the conditions observed the optimal values of drying are arranged in the following table, where the optimum of locustseed oil varnish, *i.e.*, 50 minutes was taken = 1 and all other times were recalculated to one decimal place :

Drier	Optimal values	Varnishes. Linseed	Hempseed	Locust seed	Soya bean	Poppyseed	Walnut
	Drier %	4	4	4	4	4	4
PbO	°C	225	225	225	225	225	225
	Heated hrs.	2	2	2	2	2	2
	Dry in hrs.	27.7	39.9	39.5	56.4	41.3	111.6
	Drier %	4	4	4	—	4	4
PbO_2	°C	250	250	250	—	250	250
	Heated hrs.	1	1	1	—	1	1
	Dry in hrs.	11.0	15.6	13.9	—	37.5	many months
	Drier %	4	1	4	—	1	4
Pb_3O_4	°C	175	175	175	—	250	175
	Heated hrs.	2	1	2	—	1	1
	Dry in hrs.	7.4	24.9	9.9	—	38.1	many months
	Drier %	4	4	4	—	4	4
CoO	°C	275	250	275	—	250	250
	Heated hrs	1	1	1	—	1	1
	Dry in hrs.	1.2	1.2	1.0	—	96.7	520
	Drier %	2	4	2	—	2	4
Co_2O_3	°C	175	175	175	—	175	175
	Heated hrs.	2	2	2	—	2	1
	Dry in hrs.	16.1	23.6	18.3	—	99.2	many months
	Drier %	2	2	2	—	4	2
MnO	°C	225	225	225	—	225	250
	Heated hrs.	1	2	1	—	2	1
	Dry in hrs.	10.7	5.6	17.2	—	7.1	1094

The further value deserving to be mentioned is the iodine value. One used to suppose that oils with higher iodine numbers are able to give varnishes faster drying than that with lower ones. In a certain degree this supposition was proved in the cases of poppyseed, soya bean, and walnut oil varnishes, at which really, lower iodine numbers are in accordance with remarkably longer times of drying of the final mixtures. In contrary, however, in the case of the first three varnishes, i.e., linseed, hempseed, and locustseed oil varnishes, there appears a certain disagreement. One should expect that from locustseed oil (iodine value 151.6) will result slower drying varnishes than from linseed and hempseed oils the iodine value of which is considerably higher (173.8 and 1733.3), whereas—as may be seen from the table above—the locustseed oil leads to varnishes expressively better drying. It is snre that locustseed oil gives (in the presence of CoO as drier) a varnish with the shortest time of drying at all. If one considers the rapidities of drying of all varnishes examined from the point of view of their average iodine values :

	Iodine value of the oil	Average drying of the varnish
Linseed	173.8	12.3
Hempseed ...	173.3	18.4
Locustseed ...	151.6	16.6
Poppyseed ...	132.8	53.0
Walnut	100.6	575.2

one finds that the high iodine number of the oil originally used as measure for drying of the varnish from it prepared only approximately can be applied.

Still less of value is the opinion mentioned —*i.e.*, that varnishes with a high iodine number are better drying than with a lower one—if one compares the results obtained from the point of view of their final optima of drying :

	Values	Original mixture	PbO	PbO_2	Pb_3O_4	CoO	Co_2O_3	MnO
	acid	14.02	16.14	12.83	13.20	8.87	3.90	10.75
Linseed oil	saponif	72.27	58.20	55.80	49.34	54.24	63.00	65.64
	iodine	214.6	222.6	206.4	222.3	204.5	221.7	202.6
	acid	4.48	17.52	13.55	6.21	17.07	11.16	8.81
Hempseed oil	saponif.	67.55	49.57	30.91	70.49	56.71	49.87	53.16
	iodine	213.78	216.1	213.4	202.5	209.5	218.4	218.4
Locustseed	acid	3.58	16.62	12.40	16.69	15.90	4.64	9.97
oil	saponif.	71.64	56.54	52.99	55.89	49.98	59.86	58.38
	iodine	207.9	223.2	205.1	229.1	202.8	218.9	215.2
Soya bean	acid	4.04	15.93	—	—	—	—	—
oil	saponif.	74.16	50.01	—	—	—	—	—
	iodine	201.0	220.9	—	—	—	—	—
Poppyseed	acid	5.37	25.45	16.83	6.49	4.99	16.89	16.30
oil	saponif.	72.02	49.60	55.93	70.04	59.63	58.85	53.93
	iodine	202.5	230.8	188.7	225.6	222.3	221.7	213.2
	aeid	4.93	15.46	—	—	11.87	—	10.66
Walnut oil	saponif.	72.69	55.09	—	—	53.62	—	56.75
	iodine	192.6	211.9	—	—	203.1	—	199.7

As may be seen, the iodine values increase and decrease very irregularly, and particularly striking is the increasing of this value in cases of varnishes that from slowly drying oils (soya bean, poppyseed and walnut) were prepared. All these irregularities only prove the contrary of the opinion concerning any regular connection of iodine value with the drying of oil varnishes.

A little better is the regularity of the acid values observed in the majority of experiments made. The decreasing of these numbers with increasing temperature, its time of action, and the amount of driers added, is understandable, of course, if one supposes the decomposition of glycerides present in the mixtures. Quite similar and easily explicable is the fact of decreasing of the saponification values.

The influence of temperature upon the rapidity of drying is very prominent. With increasing temperature the drying increases in all cases observed till a certain optimum, and then again decreases. All optima found the situated between 175° and 275° C., and the majority of them are limited by the interval of 225-275° C. Although several exceptions were noticed it still can be said —as has been already mentioned—that the same drier requires either the same or at least a very near optimal temperature also for different oils applied. Thus, for instance, an addition of PbO reaches its optimum in all cases at 225° C., PbO_2 (with the excep-

tion of poppyseed oil) at 2 50° C., Pb_3O_4 (with the same exception) and Co_2O_3 at 175° C., CoO at 250-275° C., and MnO between 225° and 250° C.

The optimal time of heating (to optimal temperature) fluctuates in an interval of 1-2 hours whereby a higher thermal optimum to a shorter optimum of time regularly seems to correspond, as the average temperature calculated from all 1 hour heatings is 246.6° C., while the same value obtained from all 2 hours heatings reaches only 203.6° C. Besides there seems to be of value the rule that the same drier applied requires the same optimum of time; this phenomenon can be seen the best in the cases of PbO, PbO_2, CoO, and Co_2O_3, while Pb_3O_4 and MnO show some deviations.

The rapidity of drying of oil varnishes by the kind of drier is considerably altered. For varnishes from oils with high iodine values is the best CoO which is able to lower the time of drying even below 1 hour. Very good is also the influence of MnO, a little worse effect PbO_2, Pb_3O_4 and Co_2O_3, and the worst PbO. On the contrary, *varnishes prepared from oils with a lower* iodine number show a very bad influence of CoO as drier while PbO leads to the quiskest drying products. An interesting fact noticed is that poppyseed oil varnish was obtained with MnO while the same drier for walnut oil applied gives the slowest drying mixtures.

The quantities of driers applied seem also to point to some regularties. All three oxides, i.e., PbO, PbO_2, and CoO, require, in all cases examined, an addition of 4 per cent. Pb_3O_4 need in three cases 4 and in two 1 per cent., Co_2O_3 in two cases 4 and in others 2 per cent., and MnO in all cases 2 and in one only 4 per cent. Considering the values obtained in regard of optimal temperatures and optimal amounts of driers one can observe still one regularity, *i.e.*, that higher optimal temperature seems to require a higher quantity of driers.

For judging the practical quality of all varnishes prepared the scraping test was applied. Thereby was found that mixtures obtained at lower temperatures gave films considerably brittle while varnishes prepared at optimal temperatures, *i.e.*, at 175-275° C. were smooth and resistent.

Having finished this first part of their investigations the authors are studying at present oil varnishes from other resins and will report about them in due course.

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SCIENCE TRAINING.

By Robert Saxon, B.Sc., F.C.S. (Lond.), Mem.Amer.Chem.Soc.

The Four Elements.

Fire. Antiquity has a strong appeal to young and old, and reference to the four elements, fire, air, earth, and water, as known to the ancients, will awake keen interest, and serve to show the difference between ritual and deduction. The latter in science is established by experiment, and reasoning. For that reason its findings are empirical. When we study the etymology of this word we are introduced to the word "pyra," in Latin meaning "fire," and incidentally to the fact that the methods our scientific forefathers used to try and test spurious imitations of gold from the transmutator, was by fire. Shakespeare refers to alchemy when he says :

"The fire seven times *tried* this :
Seven times tried that judgment is,
That did never choose amiss."

Also,

"Shall I think in silver she's immured
Being ten times undervalued to tried gold? "

Here the word "*try*" is cognate with the Latin *tero, tritum,* "to rub," and means to grind small or to *triturate* to detect impurity. At the present day ferriferous rocks are triturated and presented as dust to a powerful electro-magnet which, by attracting the iron compounds, gives the iron content of the rock. *Testa,* the Latin for an earthen pot, referred to the melting-pot of the refiner. So as the element fire was used to separate gold from dross it came to be recognised as the refiner of souls, giving rise through its name "pyra," to "pure, purge, purgatory, pain, and punish."

Taking mixtures of metallic wires in short lengths they may be analysed by the behaviour of the various ingredients. If metals in the form of wire be heated separately in covered crucibles the ratio in weight between metal and ash will serve to recognise the metal. The calcining of two portions of a mixture of two metals in known proportion will form a very instructive essay in simultaneous equations. The calcining of gold and platinum wire will illustrate the meaning of being "tried by fire." The calx or ash or earth should be kept for later reduction and confirmation of the ratio between it and the corresponding metal. Now we will proceed to show that the commonest and apparently most trivial objects are abounding in food for philosophy, and such philosophy ought to be apparent to

anyone who claims to have any interest in science.

In lighting a fire in the ordinary way, how many failures are due to the fact that heat is as essential to success as air, and that such fact is not recognised? Burning is a catalytic action and the heat given by the combustion of the match must break up the molecules of cellulose tissue before carbon and hydrogen may have a chance to unite with oxygen, and in uniting break up other molecules round them by the heat developed. If this heat is neutralised by cooling air the flame goes out. For this reason the fire should be laid in a nest of cinders so that air may play upon it slowly. "Why may we light the paper and not coal with a match? When the match is burning what is the liquid running before the flame? What is the black substance left by half-burnt wood? What is the ash or earth or calx left at the end of the burning?" These may be answered by experiments in calcining and distillation which any science trainer should be able to suggest.

The effect of cooling may be illustrated by the burning of magnesium. Although this metal has a great affinity for oxygen yet if the heat from the consuming part be not allowed to play on the part to be burnt the flame will die out. Initial warming up of combustible material greatly assists oxidation as the carbon molecule is very complex and its bonds disturbed from tbeir cosy self-complacency by heat are hungry for fresh activity. This is seen in the reverberatory furnace. In the engine boiler fireplace coal is introduced near the door so that the gases therefrom may pass over the red-hot coals and be burnt, instead of sooting the chimney and economiser. If the hot gases were made to heat the combustible, whether coal, coke, or oil previous to burning the result would be a gas-fire with much more caloric return than the expenditure of heat from the flue gases. In the same way if a domestic grate were designed to heat the coal or coke stored on either side the fire in chambers sealed everywhere except at the bottom leading into the bars, the result would be greater heat than the fire would give such combustibles. Solids do not burn readily, and do not remain such during combustion; it is a fact that the smith with his blast cannot command the temperature of the blowpipe, yet there is very little effort at the present time to assist destructive distillation, and to convert our agglutinating coal fire into a gas fire, and thereby reduce waste and increase the value of our coal supply.

Consider the candle as a mine of philosophy. Making a *working drawing* of the same we might ask a few questions thereon, and perform a few experiments. There will be nothing spectacular about our work, but abundance of scientific method of reasoning. Our drawing will be an introduction to conception in the third dimension, a conception woefully lacking to many who talk airily about light, sound, and other vibrations as though these operated skeins streaming out from the source, like tremulous spider filaments, instead of concentric hollow sphere-films of infinite thinness, and infinite number, centred at the source. The mere fact that phenomena square themselves with our diagram does not constrain natural forces to operate in only planes or straight lines. To return to our candle, we may note the following :—

1. Why is the wick short at the top? If it were long it would simply burn and char fouling the melted fat afterwards, and hindering capillary flow. The solid fat cannot as yet get up the wick.

2. Why is the cone truncated instead of as the dotted one WAB? A cone would allow the melting fat to run down the sides.

3. Why is the top not flat? The wick at the beginning must be short, and as such cannot melt much wax. It later becomes a taper.

4. Why is there a recess shelf at S? To arrest running wax and give preordained form to candle edge.

5. Why is the candle round? The heat operates in a circle and any shape would result in turrets at the corners.

6. Why is the wick plaited? It is intended that the wick shall bend to one side by unequal swelling during capillary flow. In the old "farthing dips" made of tallow the wick did not bend and shorten automatically with the lowering of the candle-top. The consequence was the same as that with the taper, namely, the wick goes on delivering wax until it gets top-heavy and falls with undesirable effect. The tip must reach the outer air at the flame-side so that it may be consumed by oxidation.

1. Light candle : what burns? The wick alone.

2. What happens to wax near the flame? Melts.

3. Why does top wax form a small cup? There is little flame only melting wax near it.

4. Where is the oil going? By capillary attraction it is sucked up the channels of the wick to burn inside the flame and thus prevent the wick doing so.

5. Why is the lower part of the flame invisible? It is not hot enough to be incandescent.

6. What is the luminosity due to? Carbon heated to incandescence passing upwards to cool to invisibility at the top of the flame. Such may be caught on a white surface.

7. Place a cold body as a crucible of cold water in the luminous part of the flame. Why has the flame lost a great deal of its illuminating power? The carbon motes are too cold to be incandescent.

8. Blow out the flame. What do you see *rising?* Smoke, black and grey black carbon and ash.

9. Now the wick is warm. Relight. Give two reasons why lighting is easier than at first. The wick is saturated with warm wax a gas is ascending from the tip due to the glowing heat of the tip vapourising the wax.

10. Blow out and attempt to relight by holding flame of match above but not touching the wick. What did your nose *notice when the flame was blown off the* wick? The smell of burning wax. As smell depends on emanation reaching the nostrils there must be a gas coming from the wick.

11. Why don't you notice this smell when the candle is burning? The gaseous wax is burnt in the flame.

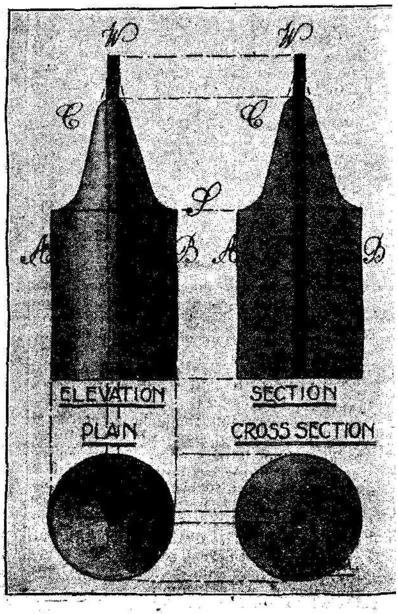
12. What did the match-flame meet before it reached the wick? The ascending wax vapour, or gaseous hydrocarbons.

13. Does solid fat burn? No, it must be rendered gaseous first, and it is easier to get gas from wood than from wax. For this reason, a wax vesta lights with more difficulty in a cold wind than a wooden one, but being more compact is more difficult to blow out once lit.

14. Blow out. Why is the wick curved? This is an example of unequal stress due to inequalities of texture. It may be compared to the bending of the compound bar by expansion. Capillary attraction has a splendid illustration of the effect of the forces bringing it about. Nothing bends unless one side elongates and the other shortens, or one by some process becomes longer than the other. *The bending of a wire or sheet of metal* lengthens the fibres or trains of molecules on one side, and done repeatedly results in rupture. This shows that when the molecules are sundered they never approach one another again. We should realise that when the sides of a tube attract a liquid to lift it up the tube, the *tube is also pulled down.* This circumferential pulling down shortens the tube. This shortening must of necessity increase the bore. Reference to the shortening of a rope by wetting will further illustrate this. As no two capillary tubes can be of the same diameter in the wick, one side must shorten more than the other, Hence the bowed head of the efficient wick and the crazy haughtiness of the unplaited bundle, as seen in the old tallow candle and the plumber's taper, requiring constant trimming.

15. Why is the wick hard? Its channels are not empty as when new, but full of frozen wax. Muscular bundles shorten and harden by virtue of the pressure within their channels.

16. Why is it black? Because the heat of combustion is great enough to decompose the wax, the hydrogen burning easily as a gas, but the carbon atoms having a great affinity for one another separate out as black motes tending to stop up the channels.



Now consider the drawing itself. Why is the wick shown in section completely, and dotted line in elevation? Sections are not taken in homogeneous bodies like a shaft, bolt, or in this case a wick. The wick is therefore drawn in elevation in the section. Hidden parts may be shown by dotted line. The cones are shown by broken line, and the projectors by dot and dash. Why is the summit line at C shown in elevation and not in section? It can be seen in elevation passing in front of the wick, but in section is hidden by the wick behind which it passes unseen. What does the dotted line S represent in section? The shelf at the back half of the candle. Why do lines like AWB consist of dashes instead of dots? they do not represent any meeting places between surfaces, or dihedral angles, but are merely hypothetical projections of imagined cones, whereas the dotted lines refer to actual objects, or edges. If two flies walk one along the line S in elevation and the other on the line S in section, at the same rate, what would be the ratio connecting the times taken by them? They are assumed to walk on the candle uncut and cut, not on the drawing. It is a good plan to press this fly into service crossing elevations, as it is a being well suited to the purpose, and serves well to bring the imagination out of the paper. Suppose the fly attempts to skate across the section, what would stop him? The wick, for it is not cut.

Thus it will be possible to consider other burners, making these working drawings, as it is essential to keeping alive that constructional talent with which all healthy children are born alive, and without which research or invention are impossible. The next burner ought to be the cycle lamp, paying attention to the fact that though a candle never gets its wick stopped up, such cannot be said for the lamp. Oils should be studied, their viscosity, ash, and luminosity noted, as well as the fabric of the wick and its ash content. At this period it will be well to study the difference between burning and smouldering, and in parallel vegetable and animal fibres.

URINARY CALCIUM.

A New Method for its Estimation.

By C. H. Collings.

No argument is needed at the present day to enforce the importance of Calcium in the human system, functionally as well as structurally. A lowered calcium content of the blood and tissues is directly prejudicial to normal functioning, and also to any process of repair, post-operative or otherwise, that may happen to be called for. Perversions of calcium metabolism, and calcium wastage, can hardly be dissociated from the question of parathyroid functioning; and this, in its turn, may implicate, if only sympathetically, the thyroid itself. Hence, it may frequently become a matter of consequence to maintain an accurate eye upon *the fluctuation of calcium output* via the urine. For this and similar reasons no apology is made for troubling those concerned with the subjoined description of a new and simple method for the quantitative estimation of the *total* CaO in the urine. With, however, one exception that does not lend itself to this method—calcium sulphate. This salt occurs as a crystalline sediment: it is extremely rare—I have examined many thousands of urines and can only recall one instance—and its presence appears to have no relation to perversions of calcium metabolism, but to be merely an incidental outcome of the ingestion of mineral waters rich in that salt—it probably passes, in fact, unaltered through the system, either wholly or in part, as may happen with various other bodies with which one is familiar in urinalysis. Speaking practically, therefore, the new method includes all the calcium salts to be found in the urine, normal and pathological. These are: calcium phosphate (in solution); calcium phosphate in crystalline forms, the acid, neutral and tribasic; and amorphous when precipitated out of solution owing to the alkalinity of the urine; calcium carbonate (in solution) and in crystalline form, nodules and particles; calcium urate; and finally a most important salt—calcium oxalate. This—like the rare sulphate—may on *occasions be derived from* exogenous sources. But such derivation, there are good reasons for saying, is the exception rather than the rule. Now, the amount of endogenous oxalate present may be very considerable, and as an index of calcium wastage, correspondingly significant.

It should be borne in mind, at this point, exactly what the limitations of the usual and accepted method are. By this method the calcium phosphate (in solution), alone, is precipitated and its lime estimated. The analyst, in cases of phosphatic sediment, alkaline urine, and so forth, may if so disposed, go out of his way and suitably modify the usual method to meet the emergency. But even this would exclude the oxalate; usually (in my own experience), of high significance both quantitatively and as regards the active causes which produce it. Hence the utility of the new method of

performing the calcium analysis, which includes *all* the forms enumerated above in one operation.

As the mode of origin of oxalic acid in the system appears to be not always understood, I may be pardoned for giving a brief idea thereof. Oxalic acid forms one of the by-products of faulty or arrested carbohydrate metabolism. It is of common occurrence under modern conditions of feeding, especially where large quantities of potatoes, refined sugar, sweetstuffs, and white-flour products (bread, biscuits, cakes, etc.) are implicated. Under these conditions—excess carbohydrate cum vitamin deprivation—the catabolic machinery frequently breaks down. For instance :—

$C_6H_{12}O_6 + O = C_4H_8O_2 + C_2H_2O_4 + H_2O$
(dextrose) (butyric acid) (oxalic acid)

Experimentally oxaluria, I may remark, has been produced (see *Herter's Lectures on Chemical Pathology* for details).

Oxalic acid in the system cannot, of course, be excreted as such, as the kidneys do not pass free acid : it at once automatically deprives the system of corresponding calcium in order to meet the demands of the excreting mechanism. The resulting calcium oxalate is, incidentally, an occasionally fertile cause of trouble in the shape of renal or bladder calculus, singly or in conjunction with other salts such as uric acid. It is worth noting that frequently a quite considerable amount of it may, in very minute form, be present in suspension in the urine and yet escape notice. If, however, the specimen be preserved with a drop or two of chloroform (well shaken up and emulsified) and stood for a day or so, a sediment may form of pure calcium oxalate. It should be further noted that the oxalate usually occurs, in the urine, in more or less colloidal form. The usual crystals, for example, will be seen to have slightly rounded angles, to polarise indifferently or not at all (in ratio to the colloid matter occluded in their structure), and, most important of all, to clump together, forming little groups of two or even many more, thus demonstrating to the eye the initiation of calculus formation.

To turn to the new calcium method. In brief, it proceeds by transforming all the calcium salts into the soluble chloride; phosphoric acid is then added, followed by *dilute* ammonia. All the calcium is thereby precipitated in the familiar phosphatic form. The CaO is then estimated in the usual manner. It should be observed that ammonia of *full* strength (.880) must be avoided as just indicated, or else has to be added in very considerable quantities, involving needless complications.

For the final titration I prefer the potassium permanganate method, as being easy, rapid and accurate; the N/20 strength as used for uric acid titration (by the Gowland-Hopkins method) answering admirably. Permanganate solution, by the way, if kept too long deteriorates.

The technique of the method is as follows. The urine may be in any condition : reaction is of no consequence : and is taken unfiltered, with an aliquot part of the sediment. (This is important.) The quantities that follow apply to 100 cc. urine, but 50 cc. is usually sufficient.

Take then, in a conical beaker, 100 cc. urine and add 10 per cent. (*i.e.* 10 cc.) of pure HCl, plus what may be needed (if any) to neutralise any alkalinity of the urine. Stir and allow to stand for 20 to 30 minutes to ensure complete solution of any *colloidal* calcium oxalate that may be present. Any sediment should be kept on the move by an occasional stir. Then add 2 cc. orthophosphoric acid (H_3PO_4) and stir thoroughly. Stand to allow precipitation of uric acid, if, any, which forms at once and soon sediments. This is the bulk of, but not necessarily all, the uric acid. Filter through a *wet* paper; the filtrate must be quite or fairly clear. In the latter case a negligible bacterial cloud may be responsible. To filtrate add a moderate quantity of *dilute* NH_3 (NH_3 .880 plus equal measure aq. dest.) when the usual type of phosphatic precipitate at once forms, but including in this case, of course, *all* the calcium, as phosphate. The top fluid may become hazy with minute spherules of acid ammonium urate in suspension, some of which will necessarily be included in the phosphatic pp.—the latter being quite obvious as such against the top fluid. Allow to settle fairly compactly, decant away top fluid, and bring pp. upon a filterpaper, washing clear of urine. Open out the filter paper, incline into a beaker, and wash off the precipitate into it with hot water. Add acetic acid to dissolve, heat, and stir thoroughly to assist solution,* neglecting any uric acid that may be in evidence. (See next paragraph but one.) On solution, add ammonium oxalate in saturated solution, to excess, to precipitate the lime as oxalate. Heat to boiling, and leave some hours (preferably over-night) to ensure good sedimentation.

If a clean sediment and no surface-pellicle of precipitate, decant away bulk of fluid, empty the precipitate on to a wet, close, filter-paper and wash beaker and precipitate

with hot water thoroughly, to eliminate residual oxalate. (Test, if doubtful, with drop of $CaCl_2$ solution). Then wash precipitate with hot water into a small beaker, already marked at 25 cc. level, make up quantity to 20 to 25 cc. with distilled water, and add 5 cc. pure sulphuric acid, stirring. (Temperature should be 60° to 70° C.) Titrate with potassium permanganate N/20. The titration should be carred out expeditiously, but towards the end it should proceed drop by drop, stirring briskly. The end-reaction is clearly shown by a delicate rose flush that persists *throughout* the liquid for several minutes.

In those cases where, as noted, acid ammonium urate has also precipitated, the necessary eliminations of such uric acid is best left till its final appearance as crystals in the formed calcium oxalate pp. for the titration. The treatment of this mixed pp. should be carried to the stage of filtering off the supernatant ammonium oxalate and washing the pp. of mixed calcium oxalate and uric acid crystals. This pp. should then be washed off the filter-paper into a small beaker, and HCl cautiously added, a drop at a time, stirring. The oxalate dissolves, leaving, of course, the uric acid. Now filter the dissolved oxalate into the calibrated titration beaker, and carefully add to it a drop or two of the diluted NH_3 to neutralise the free HCl. This automatically throws the calcium oxalate into objectivity once more, and from now on proceed as described, *i.e.*, make up quantity to 25 cc., add H_2SO_4, 5 cc., and titrate.

1 cc. of N/20 permanganate = 0.0014 gram CaO.

Normal CaO excretion, by the usual method (precipitated direct as the phosphate) is, for a typical urine, of specific gravity 1020, about 0.022 per cent.

Reagents required: HCl (pure), H_3PO_4, NH_3 (diluted, .880 + equal aq. dest.), acetic acid, ammonium oxalate (sat. sol.), H_2SO_4 (pure), pot. permang. sol. N/20, $CaCl_2$ (sat. sol.).

* A fairly common concomitant of this process (which the textbooks omit to mention) is the existence of a slight, fine residual flocculence, insoluble in acetic acid, whose presence induces the tyro to overdo the addition of acetic in the expectation of dissolving it. This stuff, under the microscope (1½″ obj.) appears as amorphous granular material in small, thin patches. It may be traced to and found in the primary phosphatic precipitate in the urine that results—following the usual method—from the addition of ammonia to the urine. At first sight soluble in HCl, it really, according to my observation, merely breaks up therein into finer, but quite objective particles. I assume it to be some proteid element of the urine, precipitated by the NH_3. In practice, I think it may be ignored, as having no material effect upon the final titration figures; in other words, the ammonium-oxalate can be added to the fluid containing it without filtering it off first.

ON THE PRODUCTION OF GLYCERINE BY FERMENTATION. VI. INFLUENCE OF SUGAR CONCENTRATION UPON THE YIELD OF GLYCERINE.

By Yoshinori Tomoda.

The fermentation experiments were carried out in the presence of sodium sulphite and the formation of alcohol and glycerine was traced during the whole period of the fermentation. As the result, it has been found that the alcoholic fermentation and the glycerine fermentation go on parallel from the beginning to the end of the fermentation. Thus the formation of a certain amount of alcohol was observed during the initial period of the fermentation, notwithstanding the presence of a large excess of free sulphite in the fermenting medium, whereas at the close end of the fermentation, where the free sulphite had been nearly exhausted, the continued formation of a certain amount of glycerine was observed.

The influence of the concentration of sugar and of sulphite upon the yield of glycerine was studied and it has been found that, at a given total sulphite concentration, the yield of glycerine is proportional to the sugar concentration of the fermenting medium, while at a given sugar concentration, the yield of glycerine is proportional to the square root of the total sulphite concentration. Thus the amount of glycerine produced in a given volume of the mash can be expressed by the following equation:—

$$w = (a + Kx)\sqrt{y}$$

Where

w = the amount of glycerine produced (g/100 cc).
x = the concentration of sugar in the mash
y = the concentration of total sulphite in the mash
a = a constant = 0.42
K = a constant = 0.11

From the above equation, the most economical concentration of sugar and of sul-

phite can be given by the following equation :—

$$y = \frac{w}{2K} \times \frac{S}{s} \quad \tfrac{2}{3}, \qquad x = \frac{w}{K \times \frac{w}{2K} \times \frac{S}{s}}$$

Where

S = the cost of sngar per unit weight

s = the cost of sulphite per unit weight

By experiments, it has been found that the presence of the acetaldehyde-bisulphite compound in the fermenting mash, favonrs the formation of glycerine and when the reaction of the fermenting medium is made alkaline, by the addition of sodium bicarbonate, the formation of glycerine becomes very marked, and it has been confirmed that in the presence of an appreciable amount of the combined sulphite (even if in the absence of any traces of free sulphite) in the fermenting medium, a considerable quantity of glycerine is formed, amounting to no less than 17 per cent. of the fermented sugar.

The author considers that the acetaldehyde-bisulphite compound is slightly dissociated into its components in the alkaline fermenting medium and the adetaldehyde thus set free is then transformed into other compounds, such as acetyl-methyl-carbinol or 2 : 3-butyleneglycol, etc., so that the remained sulphite tends to fix more aldehyde, resulting in the formation of more glycerine from the sugar present.

ACCELERLATED LABORATORY CORROSION TEST METHODS FOR ZINC-COATED STEEL.

By Edward C. Grosbeck and William A. Tucker.
(U.S. Bureau of Standards.)

The merits of two certain types of accelerated laboratory testing methods for evaluating the indicated life of the coating on hot-dip zinc-coated sheet steel were compared. The two methods studied were the simulated atmospheric corrosion, using a moist mixture of sulphur dioxide, carbon dioxide, and air, and the spray, using normal solutions of sodium chloride and ammonium chloride separately. A consistent relationship between the " life " and weight of the coating was shown by the results. The time required for the breaking down of the coating was considerably less for the first method than for the second. The coating was corroded, in the first method, in a progressive manner over the entire surface and similar to that reported for galvanised materials corroded in the atmosphere under service conditions, and in the second method, in a local and capricious manner. No attempt was made to interpret the experimental results in terms of service life in various types of atmospheres prevailing in different climates. Any satisfactory attempt at such an evaluation will have to await the results of long-time field tests on zinc-coated products carried out under several typical atmospherical conditions obtaiuing at different locations. The presence or absence of about two-tenths of 1 per cent. copper in the steel base produced no apparent effect on the results. Tests were also made on specimens which had been annealed for the purpose of converting the zinc coating into an iron-zinc alloy.

GENERAL NOTES.

THE SITUATION IN CZECHOSLOVAK INDUSTRIES.

The general industrial conditions have shown no important change during the past year. Employment continues on the whole satisfactory.

The agricultural industries and provisions branches are in general well employed. Breweries report increased production and sales. The flour mills are working satisfactorily. The malt trade is experiencing difficulties as a result of high tariffs abroad.

The output of both pit-coal and lignite in August, 1928, was in excess of that of the previous month as well as of August, 1927. Compared with the latter month the output of pit-coal rose by 4 per cent., and that of lignite by 5 per cent. The production of pit-coal coke at the same time increased by 22 per cent., and the consumption of coal altogether increased by 6 per cent. Sales of pit-coal for both the home market and export showed an advance.

Conditions in the metallurgical industry remain satisfactory, the output of iron and raw steel exceeding the previous month's figures. Blast furnaces are working at full capacity. The big demand created by building activities continues to benefit the industry. Engineering works, too, are in brisk work and report the booking of fresh foreign orders.

In the chemical trade employment is good. The production of fertilisers proceeds satisfactorily. There is a good demand for the output of the mineral oil refineries.

Favourable conditions prevail in general in the glass trade. The output of Jablonec

(Gablonz) ware, bottles and plate glass is well maintained. In the pottery trade a slight decline in orders from abroad is reported.

Conditions in the Czechoslovak textile industry are by no means uniform. Complaint is made in the cotton branch of the unfavourable trend of prices and the state of unemployment. Production is again restricted. The employment figure in this branch on September 1, was 650 below the level of the previous month. Signs of improved cotton yarn sales have appeared but the general situation in the cotton trade remains uncertain and unsatisfactory.

In the flax branch conditions are still bad, but some of the works are restarting. Flax crops have suffered from the prevailing drought. The woollen trade in general is satisfactory, though some branches show signs of a decline. Employment is satisfactory in respect of knitted ware, silk, jute, velvet and carpets output. Makers of wearing apparel report good conditions with increasing exports in some cases. The hat trade is satisfactory.

The leather and boot and shoe trades show a slight seasonal increase of output.

In connection with the building trade, employment in lime works, kilns, cement and concrete works is favourable. The demand for building materials continues and stocks are low.

Employment is satisfactory in the timber trade. The sawmills are working at high pressure to meet the calls from the home market as well as for slightly increased exports. Complaints of difficulties, however, come from the bentwood furniture branch. The paper trade is doing well. The output of musical instruments is increasing, but the pre-War level has not yet been recovered.

An international conference on Standardisation is to be held at Prague at the end of this month.

GOVERNMENT FUEL RESEARCH LABORATORIES, OTTAWA.

The Mines Branch of the Dominion Department of Mines has just forwarded to the High Commissioner for Canada in London a copy of Memorandum No. 34, giving a description by Mr. B. F. Haanel of the new fuel research laboratory building recently erected at Ottawa, in order to conduct extensive investigations into the properties of Canadian solid, liquid and gaseous fuels.

The Memorandum in question may be consulted by persons interested on application to the Office of the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

THE SHERITT-GORDON MINES IN CANADA.

According to a recent issue of the *Canada Gazette*, the Minister of the Interior has conceded the Sheritt-Gordon Mines, Ltd., operating in the vicinity of Cold Lake, Manitoba, exemption from payment of royalties for a period of 20 years, together with permission to export for final treatment the blister copper produced on the properties.

Quartz mining regulations generally in force on Dominion lands in Western Canada require that all ores or minerals mined on leases granted by the Department of the Interior shall be treated or refined in Canada, and that royalty shall be paid on the sales of products of such mining.

The Order-in-Council just published explains that Sherritt-Gordon Mines, Ltd., has acquired mineral claims comprising an area of about 5,400 acres, and has expended appproximately $650,000 on prospecting and development; that a deposit of low-grade ore has been disclosed, containing copper and zinc, with a small percentage of gold and silver; and that for commercial development and maximum recovery of the minerals it will be necessary to erect a mill, smelter, and other reduction works at an approximate cost of $10,000,000. The construction and completion of the necessary plant and works, it is stated, will require a period of approximately four years and when brought to the production stage at the tonnage estimated, will require the employment of about 1,000 persons.

Exemption from the obligation to refine in Canada the blister copper produced at Sherritt-Gordon mines is granted in view of the fact that in order to complete in Canada the final refining process it would be necessary to despatch the product to a Pacific coast smelter and to return the refined metal to markets in Eastern Canada, thus involving an additional haul of over 2,500 miles. Nevertheless, the erection of the mill, smelter and other reduction works which are contemplated are expected to be of great utility in connection with the preparation for market of Manitoba and Saskatchewan ores, and exemption from royalties on the metals to be produced is conceded in view of the pioneer character of the enterprise, as well as in view of the fact that no reduction works of a similar character have yet been established in the Province of Manitoba.

If the report in question should be confirmed the discovery may mean much to the northern districts of the Province of Saskatchewan ,emphasising, as have already the Flin Flon and Sherritt-Gordon operations, that mining in the north country may within the next few years be of very great importance.

Proceedings and Notices of Societies

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, Thursday, October 18 :—

Studies of Dynamic Isomerism. Part XXVIII. Absorption Spectra of the Ketonic and Enolic Forms of an α-Diketone. By T. M. LOWRY, H. MOUREU AND C. A. H. MACCONKEY.

Benzylmethylglyoxal, $C_3H_5.CH_2.CO.CO.CH_3$ shows an absorption band in the visible spectrum, with a maximum log ε = 1.5 at 4300 in alcohol or log ε = 1.8 at 4550 in *cyclo*hexane, but the spectrum shows only a " step-out " in the ultra-violet at about 3000 A. The enolic isomeride, $C_6H_5.CH : C(OH).CO.CH_3$, on the other hand is colourless, but has a strong absorption band in the ultra-violet with a maximum log ε = 4.3 at 3120 in alcohol, or 4.7 at 3100 in *cyclo*hexane. Both bands are given by solutions in which the two isomerides are in equilibrium.

Explosions in Closed Cylinders. By W. A. KIRKBY AND R. V. WHEELER.

Part I. Methane-air explosions in a long cylinder.—Mixtures of methane and air were exploded in a cylinder 200 cm. long and 10 cm. in diameter and records obtained of the movement of flame and the development of pressure. It was found that (*a*) When ignition was at one end of the cylinder, there was a rapid rise in pressure shortly after ignition, corresponding with a rapid movement of flame over the first 20 or 30 cm. There was then an arrest in pressure development, corresponding with an arrest in pressure development. Finally, as the flame moved rapidly, and in a strongly vibratory manner, towards the end of the cylinder, there was a rapid rise in pressure to a maximum. (*b*) When the position of the point of ignition was varied, the maximum pressure was recorded wren ignition was at the middle of the cylinder. (*c*) With dual ignition, no higher pressure was obtained than with single ignition at the middle of the cylinder. A sustained period of maximum pressure was obtained when the two ignition-points were a considerable distance apart.

Part II. The effect of length of the cylinder.—The length of the cylinder (10 cm. diameter) was varied, the object being to determine the limiting length at which the flame in a 95 per cent. methane-air mixture became vibratory, ignition being at one of the cylinder. This was found to be 140 cm. With shorter lengths, the movement of flame and the rate of production of pressure were regular, the time-pressure records being characterised by a steady period of maximum pressure. All such explosions were quite silent. When the cylinder was 140 cm. long, or longer, the explosions were vibratory and accompanied by a shrill " screech." The maximum pressures were recorded in the shorter lengths of cylinders.

Explosions in Closed Cylinders. Part III. The Manner of Movement of Flame. By O. C. DE C. ELLIS AND R. V. WHEELER.

Some of the phenomena of explosions of methane and air in closed cylinders described in Parts II and III are explained by means of " snapshot " photographs of flames moving under similar conditions in glass cylinders.

It is shown that the rapidly increasing speed of flame (and development of pressure) during the early stages of an explosion in a long cylinder, ignition being at one end, are due to the rapidly increasing area of the flame-surface as it spreads from the point of ignition. The marked retardation and subsequent slow movement of flame are due to a sudden decrease in the area of the flame-surface, consequent on the contact of all but its front with the walls of the cylinder, and the sudden increase in the area over which the products of combustion are cooling.

When the point of ignition is moved from the end, the flame surface tends to centre itself within the cylinder, moving most rapidly towards the region of greatest volume. Because of its extended area, cooling when the flame surface touches the walls is therefore excessive. With dual ignition, the two flames hinder each other's development, each developing a smaller surface area than it would if the other were absent.

In cylinders of different lengths, ignition being at one end, the flame-surface moves the more freely along the axis of the cylinderder the greater is its length. At the moment when the flame-surface has made contact with the walls, and rapid cooling of the products of combustion has begun, a

greater proportion of the mixture has burnt in the shorter than in the longer cylinders, so that higher maximum pressures would be recorded in the former.

Pentanitroaniline. By B .FLURSCHEIM AND E. L. HOLMES.

When 3 : 5-dinitroaniline is nitrated with mixed acid, nitroamides separate which tend to decompose with violence, but under certain conditions their further transformation into pentanitroaniline has been accomplished. Pentanitroaniline crystallises from benzene in golden-yellow prisms containing 1 molecule of benzene which is readily given off. The decomposition point of the benzene-free material is 192°.

With aqueous ammonia, pentanitroaniline yields 2 : 4 : 6-trinitro-1 : 3 : 5-triaminobenzene, with methyl alcohol 2 : 4 : 6-trinitro-5-aminoresorcinal dimethyl ether, m.p. 127.5°; with ethyl alcohol the corresponding diethyl ether, m.p. 127.25-127.75°; with sodinm acetate and acetone or sodium carbonate 2 : 4 : 6-trinitro-5-aminoresorcinal, whence trinitrophloroglucinol, m.p. 167°, is produced by potassium hydroxide. These reactions prove that all the five nitro-groups are in the nucleus.

THE OPTICAL SOCIETY.

At the meeting of the Optical Society held at the Imperial College of Science and Technology, South Kensington, on Thursday, 11 October, the following papers were read and discussed :—

Lenses for Equipment for Ultra-Violet Photography. By COLONEL J. WILLIAM GIFFORD, F.R.A.S.

A description is given of the type of photographic doublet generally known as rapid rectilinear, in which (1) fluorite and quartz, (2) quartz and calcite are substituted for the ordinary crown and flint glasses. These doublets are therefore more or less transparent to the ultra-violet as well as to the visual spectrum. Corresponding lists of focal lengths for twenty-one wavelengths are given, as well as the radii, thicknesses, etc., for construction. A cement transparent to the ultra-violet for use with these lenses is described and photographs of the spectra transmitted by certain light filters are given.

Some Remarks on Old English Objectives. By H. BOEGEHOLD, Ph.D.

The objective for the old Ramsden telescope in the possession of the Schleiermacher family was examined.

Constructional data, refractive indices and v-values for this objective are given in the paper.

In addition, there are notes of historical interest.

On the Development of Spectacles in London from the End of the Seventeenth Century. (First Paper on the Court Collection.) By THOMAS H. COURT AND MORITZ VON ROHR.

We are able to extend our knowledge of the development of spectacles by consulting modern collections, the Court Collection especially. English spectacles before 1666 are very imperfectly known; we can only make inferences about them. After the Great Fire our knowledge becomes more intimate and we note that horn spectacles with rigid and with split frames are advertised and that unwieldy leather frames (of unknown shape) appear for a short time together with the then popular " hinged spectacles." Marshall's improvement in grinding and polishing a number of surfaces at the same time must also be mentioned here. In the 18th century the London artisans became the leading spectacle opticians as they developed the temple spectacles and very efficient nose spectacles in horn and steel. The authors have tried to collect as much information as possible about these forms and to give their ideas about the outward appearance of the spectacles then in use. Minor inventions also are mentioned and Walker's untenable objections to Wollaston's periscopic spectacles treated. The 19th century was not a favourable period for the master craftsman in London, as large spectacle factories (in Rathenow and in the United States) altered the position of the spectacle vendors.

Votes of thanks to the authors were moved from the chair and accorded with acclamation.

An interesting display of early spectacles and trade cards from the Court collection, arranged by Mr. Court and Mr. Baxendall, added to the interest of the evening.

After the papers had been read and discussed, Mr. Z. A. Merfield, of Melbourne University, gave an interesting account of the history of the Grayson rulings and Grayson's ruling engine. He also gave a brief account of the work in ruling diffraction gratings at present being carried out at Melbourne by himself and Professor Lyle, and exhibited three fine specimens of their work.

On the motion of the Chairman, Mr. Merfield was cordially thanked for this interesting account.

ROYAL INSTITUTION.

The courses of lectures arranged at the Royal Institution during November and December will commence with the Tyndall Lectures to be delivered by Professor H. L. Callendar, who will give three lectures on "Co-aggregation *versus* Continuity in the Change of State from Liquid to Vapour," beginning on Tuesday, October 30, at 5.15 p.m.; and on Tuesday, November 20, Sir William Bragg delivers the first of four lectures on "Diamonds." On Thursday afternoons beginning on November 1, there will be lectures by Captain G. Pitt-Rivers on the "Clash of Culture (1) Race and Culture; (2) Culture-clash in a Maori Village; (3) The Empire and the Native Problem"; two by Dr. E. D. Adrian on the "Mechanism of the Nerves," and two by Sir Richard Paget on "Human Speech as (1) A Method of Expression by Gesture, (2) A Musical Phenomenon: Some Conclusions." On Saturday afternoon, November 3, at three o'clock, the Rev. T. E. R. Phillips will deliver the first of two lectures on "Recent Observations and Discoveries respecting the Planets"; on succeeding Saturdays there will be three lectures by Dr. W. G. Whittaker on (1 and 2) "North Country Folk Music; (3) Violin Sonatas of William Young," with musical illustrations; and Mr. Wilter Bayes will give two lectures on "The Gulf Between Painter and Public."

The Juvenile Lectures this year, the 103rd Course, will be delivered by Mr. Alexander Wood, on "Sound Waves and their Uses." (1) Waves (December 27); (2) Signalling in Air and Water (December 29); (3) Notes and Noises (January 1); (4) How Sounds are Analysed (January 3); (5) The Ear and What it Does (January 5); (6) How Sounds are Recorded and Reproduced (January 8).

NOTICES OF BOOKS.

Higher Certificate Chemistry Test Papers. By J. Morris, M.A. Pp. VIII + 86. London: Methuen & Co. 1928. Price 1s. 6d.

This book contains fifty test papers, of Higher Certificate standard, with an additional sixty miscellaneous questions of somewhat greater difficulty. The author has, by careful study of the Higher Certificate Syllabuses and recent questions set by the various examining boards, been able to produce a set of papers invaluable for students taking any Higher Certificate Chemistry Examination, or London University Intermediate. Selected questions from recent papers help to standardise the tests, while hints and solutions form a valuable feature of the book.

The Fundamentals of Chemical Thermodynamics. Part I. By J. A. V. Butler. Pp. XII + 207. London: Macmillan & Co. 1928. Price 6s.

The importance of the thermodynamical method in chemistry is now widely recognised but whilst there are a number of larger treatises on the subject for the use of advanced workers and reference purposes, the present volume by Mr. Butler appears to be the first which is intended to meet the needs of general students. The subject is presented in a clear and logical manner without the introduction of much mathematics with which some chemistry students have little sympathy. The author deals with the first and second laws of thermodynamics, changes of state, phenomena associated with solution, homogeneous gaseous reactions, the galvanic cell, electrode potentials and electrolysis. The present volume is thus based mainly on cyclic processes. A second part is in preparation, we are told, which will deal with more advanced parts of the subject.

Atlas der letzten Linien der wichtigsten Elemente. By Dr. Fritz Löwe. Pp. 44, with 16 photogravure plates. Leipzig and Dresden: Theodor Steinkopff. 1928. Price 12 marks.

Prof. Löwe, who is one of the eminent physicists connected with the firm of Zeiss, Jena, has compiled a list of the spectral lines of the 64 most important elements, and has illustrated the work with photogravure reproductions of the plates. A German writer has written, concerning the work:—

Das Hauptgewicht der Darstellung hat der Verfasser auf die praktischen Bedürfnisse bei der Ausführung der qualitativen und der quantitativen Spektralanalyse gelegt.

Es werden deshalb auch nur die empfindlichen Linien wiedergegeben, die von den Elementen noch ausgesandt werden, wenn sie in geringer Konzentration in einer Mischung, Legierung, Lösung u.s.w. enthalten sind. Weiter wird von jedem Spektrum nur der Ausschnitt gebracht, der die empfindlichen Linien des Elements enthält und den der Analytiker allein braucht. Die Vorteile dieser Darstellung liegen darin, dass dem Benutzer der Atlasses gezeigt wird, wie die empfindlichen Linien eines Elements verteilt oder gruppiert sind und wie ihre Zahl und ihre Intensität abnimmt mit abnehmender Konzentration. Von Jedem der ausgewählten Elemente werden

4 Spektra gebracht in den Konzentrationen 1 per cent, 0.1 per cent., 0.01 per cent., und 0.001 per cent.

Besonders wertvoll wird der Atlas durch die neubearbeitete Tabelle der letzten Linien von 64 Elementen, die eine durch die Aufnahmen des Verfassers erganzte Zusammenfassung der Ergebnisse der Klassiker darstellt; die Werte der Wellenlängen wurden aus denen der Kayserschen Tabelle durch Abrundung auf 0.1AE abgeleitet.

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Forthcoming Events.

THE FARADAY SOCIETY.

The 25th Anniversary of the Foundation of the Society will be celebrated on Friday, 9 November, 1928.

At 3.30 p.m. there will be delivered in the Lecture Theatre of the Royal Institution, Albemarle Street, W.1. (at the kind invitation of the Governors) the First Spiers Memorial Lecture (delivered in accordance with the terms of a Trust founded to keep alive the memory of the late Frederick Solomon Spiers, a Founder of the Society, and its Secretary and Editor throughout the period of its history until his death on 21 May, 1926). Sir Oliver Lodge, F.R.S. (the senior living Past-President of the Society), will lecture on " Some Debatable Problems in Physics." The chair will be taken by Sir Robert Hadfield, Bart., F.R.S.

A joint meeting of the Faraday Society and the Electroplaters' and Depositors' Technical Society will be held in the Lecture Theatre, Northampton Polytechnic Institute, St. John Street, E.C.1., on Wednesday, 31 October, 1928, at 8.15 p.m., when the following papers will be discussed :—

" The Causes and Prevention of Pitting in Electro-deposited Nickel." By D. J. Naenaughtan and A. W. Hothersall (*Trans. Far. Soc.*, xxiv, 497).

" On the Effect of Colloids in the Electro-Deposition of Silver from Silver Nitrate Solutions." By S. Wernick (*Trans. Far. Soc.*, xxiv, 361).

" The Hardness of Electro-Deposited Nickel." By D. J. Macnaughtan and A. W. Hothersall (*Trans. Far. Soc.*, xxiv, 387).

" Investigations on the Electro-Deposition of Silver." By Edward B. Sanigar.

The papers will be summarised in a few

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,682.—Benckiser, J. A. (Firm of), Benckiser, T., and Reimann, A.—Production of a disodium phosphate. October 5th.

28,714.—Boehringer, A., and Boehringer Sohn, C. H.—Manufacture of derivatives of dihydro-codeinone, etc. October 6th.

28,623.—I. G. Farbenindustrie Akt.-Ges. —Recovery of oils from aqueous emulsions. October 5th.

28,683.—Kali-Industrie Akt.-Ges., Kristenssohn, A., and Thorssell, C. T.—Production of potassium carbonate. October 5th.

Specifications Published.

297,692.—Newport Co.—Process of making N-dihydro 1, 2, 2′, 1′ anthraquinone azine.

277,953.—Jungmann, Dr. K., and Kolbert, Dr. O.—Process for the manufacture of a solid alcoholic solution of free iodine.

278,696.—Du Pont de Nemours & Co., E. I. —Prevention of livering in pigmented carbohydrate - compound compositions.

Abstract Published.

295,744.—Organo-arsenic compounds. — Newberry, G., Stanmer, Blake's Lane, New Malden, Surrey, and May & Baker, Ltd., Garden Wharf, Church Road, Battersea, London.

Oxyacetic acid derivatives of arylarsinic acids are prepared from *o*-amino-oxarylarsinic acids by first protecting the amino group, *e.g.*, by introduction of an acyl group such as acetyl or benzoyl, and then treating the acid with an α-halogen-acetic acid or readily hydrolysable derivative thereof, such as the amide or an ester. By hydrolysis of the product, the protecting group is eliminated and the *o*-substituted residues condense to form the corresponding isoxazine compound. The latter may also be prepared without isolation of the intermediate product. According to the examples, (1) 3-acetylamino-4-hydroxyphenylarsinic acid is condensed with chloracetic acid or chloracetamide; hydrolysis of the result-

-phenoxyacetamide-1-arsinic acid yields 3-hydroxy-1 : 4-benzisoxazine-6-arsinic acid; (2) 3 : 5-diacetylamino-4-hydroxyphenylarsinic acid condenses with chloracetic acid to give the corresponding phenoxy body, which, by hydrolysis, forms 8-amino-3-hydroxy-1 : 4-benzisoxazine-6-arsinic acid; acetylation of the latter gives the 8-acetylamino compound, which is described in *Specification 278,444. Specification 280,613* also is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SUL.

493,514.—Chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes. — Lewis Charles Wallach, 16, Finsbury Square, London, E.C.2. October 3rd.

TYLAMMON.

494,489.—All goods in class 1 which includes acids, potash, salts, and other chemical substances used in manufactures. — Adler-Farbenwerke und Chemische Fabrik Aktiengesellschaft, 50, Herkulesstrasse, Essen, Germany. October 3rd.

FIGADEX.

493,708.—Chemical substances prepared for use in medicine and pharmacy.—The British Drug Houses, Ltd., 16 to 30, Graham Street, City Road, London, N.1. Octaber 3rd.

TONTE.

492,755.—Chemical substances prepared for use in medicine and pharmacy.—Caulin & Co., 28, Willes Road, Leamington Spa. October 10th.

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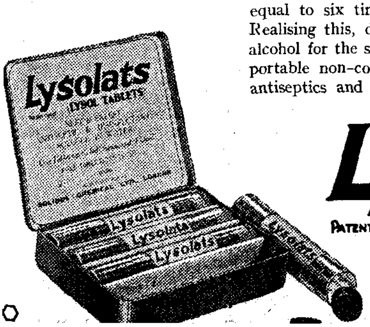

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ELECTRONS, LIGHT, AND WAVE-MECHANICS.

It is now known that electrons simulate X-rays as the following summary of recent work reveals :— Electrons behave as if they were waves as shown by the experiments of Dymond (*Nature*, 1926, 118, 336—the reference here and those below are in the sequence : *year, vol., page*) on the scattering of electrons in gases. Also their wave characteristic is made evident by their reflection from crystal faces as shown by Davisson and Germer (*Phys. Rev.*, 1927, 30, 705); see Davisson and Kunsman (*Science*, 1921, 54, 522; *Phys. Rev.*, 1927, 22, 242) and Davisson (*Journ. Franklin Inst.*, 1928, 206, 597). Germer (*Journ. Chem. Education*, 1928, 5, 1041) concludes a clear semi-popular account of this work with the following statement :— "*It is quite certain that electrons are diffracted by a nickel crystal as if they were waves having a wave-length given by the quotient of Planck's constant and the electron momentum, mv.*" That is to say, the theoretical relation connecting wave-length and voltage is derivable from $\lambda = h/mv$, m being the mass of the electron and v its velocity, which is in accord with the new wave-mechanics . . . and finally $\lambda = 12.25/V^{\frac{1}{2}}$ when λ is given in Angström units and V is the volts. G. P. Thomson (son of Sir J. J.) has shown that in the passage of high-speed electrons through exceedingly thin sheets of metal, or celluloid, the electrons behave like X-rays of very short wave-length, for G. P. Thomson has succeeded in photographing the diffracted rays (electrons) which impress on the plate a series of concentric rings, and in some cases spot patterns as well, all of which are in close agreement with the behaviour of X-rays. See G. P. Thomson's researches : *Proc. Roy. Soc.*, 1928, 117, 600, and later publications. It should be noted that the wave-lengths in this case are in accordance with the first equation above when the relativity correction is allowed for, and that the diameter of the diffraction rings divided by the wave-lengths gives a constant.

Now light, whatever the wave-length, is not deflected in a magnetic field as are moving electrons, and there are other differences. Notwithstanding these marked disparities the electrons *seem* both to carry trains of waves with them and to follow the lead of these waves.* The dispersion curve for nickel has been established, and Davisson and Germer " have also observed a phenomenon [in addition to reflection and refraction] which is suggestive of optical anomalous dispersion," and there are G. P. Thomson's experiments showing diffraction rings—and all this with the " light-heeled electrons " ! One can *almost* say : there are only two fundamental activities in the world, those of the electron and those of life,* all else being inert matter that does not so much matter; but there is the velocity of light which represents *radiation*. It might be better to say that there are *three* activities, namely those of : (1) gross matter (2) *electrons and* (3) *radiation*; but if radiation becomes attached, as it were, to the electron, or they merge at extremes, then the number reduces to two : gross matter and radiation. I have discussed a similar idea before in connection with radioactivity as readers of this Journal may remember. See *Chemical News*, 1924, 128, 113. The term *gross matter* can be interpreted broadly according to circumstance.

I have suggested in these pages† that the light-velocity (c) was in effect, or fundamentally, a spreading constant. I have also said that anything moving with the velocity of light might spread. Now if electrons could be made to move with the velocity of light they should spread, and recent experiments, as above, indicate that electrons behave as do light waves, or they become attached to light waves, using the word *light* in the generic sense. This looks suggestive, in that a wave is a spreading phenomenon, as a

* See Beyond the Electron, 1928, by Sir J. J. Thomson.

* I have often thought that as potassium is necessary to all life and as it has some type of radioactivity, for it emits β-rays (perhaps re-absorbs them as well —see my letter in *Nature*, 1926, 117, 448), it may be this activity which sets up movements in atoms and molecules whereby they become organised, and life thus starts. Then events follow the first directed movements and they are governed by the environment. The movement is suitable to the environment, and the environment becomes modified in time as the result of movement, so that a *purpose*, so to speak, grows out of the initial activity which may be that of the electrons in connection with potassium. I might quote the famous lines of Democritus and be as near to the basis of life as anybody truthfully can claim to-day (see in this connection D'Arcy W. Thompson in *Nature*, 1928, 121, 566).

† See, for example, *Chemical News*, [illegible]

stone dropped into a pond produces circumferentially larger and larger waves. *It must, however, be remembered that some of the words used, as in the sense above, are not the correct words, because, there is a mystery attached to these phenomena that restricts the utility of language.*

I have shown* that the velocity of light can be computed from the Rydberg constant R_∞ and Planck's constant of action h when introducing a numerical value 24×10^{-33}. Incidentally I assumed, in this connection, that the precise values of R_∞ and h involved repeating, or recurring, decimals (it is known that such decimals are examples of infinite geometrical progression, and that geometrical progression is commonly met with), but this detail is only a guess, and it may not be proved, yet the equation gives a satisfactory answer, which is—

$R_\infty/(24 \times 10^{-33}/h) = 299796$ kms. per second (Michelson's latest vacuum value) when

$$R_\infty = 109737.\dot{3}\dot{7}, \text{ and}$$

$$h = 6.55\dot{6} \times 10^{-27}.$$

The question arises here Can this relation be brought into line with the new wave-mechanics?

This is a red-letter day for the mathematicians who have evolved the new wave-mechanics, for all these experiments give overwhelming evidence that the wave theory of mechanics is fundamentally sound. This wave theory makes use of Einstein's theory of relativity that has proved to be so successful in dealing with a wide range of phenomena.

The question may be asked Is this new theory destined to rule supreme over all classes of mechanics taking in Einstein's theory in its stride? Some will say that it is limited to electron 'movements,' or the fine-grained optical phenomena of nature; but Einstein's theory covers the complete range of phenomena to which it was applied. Why should not this wave theory be equally embracing?

In the hands of Millikan and Cameron, these two great theories and Aston's findings have served as tools to yield up secrets of nature never dreamt of before. The cosmic rays, or Hess-Kolhörster radiations—to use the term recently applied by Nernst (*Journ. Franklin Inst.*, 1928, 206, 135)—seem to arise from the actual manufacture of abundant elements (He, O, Si, and possibly Fe) in inter-stellar space where the temperatures are very low bordering on the absolute, to put it a little crudely. In the *Physical Review* for October, 1928, the complete theory supporting this idea is promised.

Jeans' recent contributions in this astronomical field seem to be confined mainly to liquid stars where a super-radioactivity takes place, electrons and protons completely neutralising each other in massive atoms which gravitate to the star's central regions; and, as a consequence of this state of affairs, involving Einstein's mass-energy theory, a high-frequency radiation is produced in these central regions, and this transforms into temperature radiation in passing through the star's interior, and issues as such.

Einstein's mass-energy theory comes to this: If mass disappears it must disappear at the speed of light if it (mass) is converted into radiation. Now the energy involves the square of the velocity. Therefore, Mass × Velocity of Light Squared = Energy in Ergs, which is Einstein's equation, C.G.S. units being used.

F. H. L.

* See, for example, *Chemical News*, [illegible]

CORRESPONDENCE.

SAFEGUARDING.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,—The present phase of the fiscal controversy is becoming as notable for what Mr. Baldwin might well call the "many-sidedness of truth," as was its precursor in pre-war days.

When Safeguarders congregate their unanimity is wonderful, but when their testimony is taken separately we get strange diversities, as for instance:—

"By Safeguarding we have built up new and vital industries. We have built up a chemical industry second to none as the result of our policy."—Sir P. Cunliffe-Lister, President of the Board of Trade, Norwich, September 28, 1928.

"The only branch of the chemical industry which is Safeguarded is that of fine chemicals, which employs, and never is likely to employ more than, a trifling percentage of the total number engaged in the industry."—Mr. H. G. Williams, Parliamentary Secretary to the Board of Trade, House of Commons, March 21, 1928.

It is odd that the two Parliamentary representatives of a great State Department should thus give the lie to one another, but perhaps there is an explanation.

Yours faithfully,
H. E. CRAWFURD, M.P.

House of Commons.
October [illegible], 1928.

THE COLLINSICS OF MINERALS. VI.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In Table IX twelve more collinsics are given. Beryllium, the only new introduction, comes into the constitution of eight of them. At present this element is only known to have one relative volume (4.62) and therefore one invariable value for O.R. (3.733).

Leucophanite (No. 61) is here taken as an example for the explanation of all collinsics again. Dana gives two values, 2.959 and 2.964 for the S.G. If the molecular weight, 243, be divided by 2.959 and also by 2.964, the molecular volumes are 82.12 and 81.98 respectively. Therefore the sum of the atomic volumes *must* amount to about 82, this number being fixed by the specific gravity. The actual sum of the atomic volumes given in No. 61 is 82.235. When 243 is divided by this number the theoretical S.G. 2.955 is obtained.

Immediately the atomic volumes are *fixed, the atomic refractivities* are also fixed; aud the sum of the latter is 48.566 in this case. In order that this collinsic may be true, it is necessary that the latter sum should be equal (correct to four figures) to the product obtained by multiplying the sum of the atomic volumes by $\mu - 1$.

There is very little room here for any juggling with figures in such a way that one might be accused of producing irregularities, which are only imaginary. The same remark applies to nearly all minerals. But in the case of Beryl, No. 64, there are a great number of experimental determinations of S.G. Winchell gives them as lying between 2.63 and 2.91. Spencer gives more than a hundred determinations from 2.545 to 2.91. Of course the variations are due to variable impurities. Also the R.I. for the ordinary ray varies greatly for the same reason. Winchell gives 1.568 to 1.602. Notwithstanding these variations the collinsic demonstrates the state of affairs with regard to the pure mineral with practical certainty of its being the truth, because it is in conformity with all other collinsics in the manner which has been frequently demonstrated.

The collinsics form an important part of the operation of unravelling the Constitution and Structure of Atoms. As an example of the progress made Mg may be taken as an example.

TABLE VIII.

	Mg		C		C
At. wts.	24	=	12	+	12
R.V.	8.71	=	8.0	+	0.71
O.R.	6.0015	=	3.333	+	2.6685

8.0 and 3.333 are the relative volume and optical refractivitp respectively of an atom of carbon when united to two valences of an atom of oxygen. 0.71 and 2.6685 are the R.V. and O.R. of carbon when each of its four valences is joined to a separate atom. These values occur in hundreds of organic substances.

All three of these exact coincidences show that an atom of magnesium has been produced by the union of two atoms of carbon.

In the *Chemical News*, 1925, CXXXI, 212, the structure of magnesium was investigated, and other reasons were there given for the same conclusion.

This matter is only mentioned here in order to give an idea of what may be expected when the collinsics are finished, for a suggestion has rather inconsiderately been made by a mineralogist that they will ultimately lead to nothing.

TABLE IX.

THE COLLINSICS OF TWELVE MINERALS.

		Theor. Column	Obs. Column	
(61)	Leucophanite Na + Be + F + Ca + Si + Si + O_2 + O_4			
		2.955	2.959	D
	48.56 = 0.5905(11.865 + 4.62 + 5.42 + 14.54 + 13.83 + 13.02 + 4.45_2 + 2.51_4)			
		1.5905	1.5909	D
	48.566 = 3.865 + 3.733 + 0.26 + 10.52 + 9.78 + 11.53 + 1.747_2 + 1.346_4			
			N_m 1.595	W
(62)	Bertrandite H_2 + Be_4 + Si_2 + O_2 + O_7			
		2.596	2.593	Bert
			2.598	D
	52.327 = 0.5707(5.76_2 + 4.62_4 + 17.61_2 + 4.45_2 + 2.51_7)			
		1.5707	1.569	D
	52.324 = 2.613_2 + 3.733_4 + 9.025_2 + 1.747_2 + 1.346_7			

(63) Phenacite $Be_2 + Si + O + O_3$

$$24.687 = 0.6615(4.62_2 + 13.02 + 7.53 + 2.51_3)$$

$$24.688 = 3.733_2 + 11.53 + 1.654 + 1.436_3$$

Column Theor.	Column Obs.	
2.95	2.95	Hatch
1.6615	1.654	D
	1.6673	D

(64) Beryl $Be_3 + Al_2 + Si_6 + O_2 + O_{16}$

$$114.565 = 0.571(4.62_3 + 9.05_2 + 18.91_6 + 7.53_2 + 2.51_{16})$$

$$114.539 = 3.733_3 + 7.865_2 + 10.461_6 + 1.654_2 + 1.346_{16}$$

Column Theor.	Column Obs.	
2.676	2.676	Spen
	2.67 - 2.69	D
1.571	1.572	D
	N_0 1.568 - 1.602	W

(65) Euclase $Be + Al + H + Si + O + O_4$

$$31.128 = 0.6519(4.62 + 9.05 + 5.76 + 13.83 + 4.45 + 2.51_4)$$

$$31.122 = 4.733 + 7.865 + 2.613 + 9.78 + 1.747 + 1.346_4$$

Column Theor.	Column Obs.	
3.036	3.036	Mall
1.6519	1.652	D

(66) Meliphanite $Na + Ca_2 + Be_2 + F + Si_3 + O_3 + O_7$

$$76.6336 = 0.59863(11.865 + 14.54_2 + 4.62_2 + 5.42 + 13.83_3 + 4.45_3 + 2.51_7)$$

$$76.634 = 3.865 + 10.52_2 + 3.733_2 + 0.26 + 9.78_3 + 1.747_3 + 1.346_7$$

Column Theor.	Column Obs.	
3.00	3.006	D
1.59863	1.60	M

(67) Chrysoberyl $Be + Al_2 + O_4$

$$24.847 = 0.75846(4.62 + 9.05_2 + 2.51_4)$$

$$24.847 = 3.733 + 7.865_2 + 1.346_4$$

Column Theor.	Column Obs.	
3.877	3.86	Chur
1.75846	1.7565	D

(68) Eudidymite $H + Na + Be + Si_3 + O_2 + O + O_5$

$$51.3346 = 0.53588(5.76 + 11.865 + 4.62 + 13.83_3 + 7.53_2 + 4.45 + 2.51_5)$$

$$51.3360 = 2.613 + 3.865 + 3.733 + 9.78_3 + 1.654_2 + 1.747 + 1.346_5$$

Column Theor.	Column Obs.	
2.557	2.553	D
1.53588	1.54444	D

(69) Clinochlore $H_8 + Mg_5 + Al_2 + Si_3 + O_{18}$

$$122.22 = 0.583(5.76_8 + 8.71_5 + 9.05_2 + 18.91_3 + 2.51_{18})$$

$$122.25 = 2.613_8 + 6.0015_5 + 7.865_2 + 10.461_3 + 1.346_{18}$$

Column Theor.	Column Obs.	
2.643	2.648	D
1.583	1.583	D

(70) Leverrierite $Al_4 + Si_5 + O_5 + O_8 + O_3 + 5H_2O$

$$148.26 = 0.5878(9.05_4 + 13.02_5 + 7.53_5 + 4.45_8 + 2.51_3 + 14.03_5)$$

$$148.254 = 7.865_4 + 11.53_5 + 1.654_5 + 1.747_8 + 1.346_3 + 6.572_5$$

Column Theor.	Column Obs.	
2.355	2.3 - 2.4	D
1.5878	1.6	D

(71) Gmelinite $Na_2 + Al_2 + Si_4 + O_5 + O_7 + 6H_2O$

$$119.04 = 0.473(11.865_2 + 9.05_2 + 17.61_4 + 7.43_5 + 2.51_7 + 14.03_6)$$

$$119.084 = 3.865_2 + 7.865_2 + 9.625_4 + 1.654_5 + 1.346_7 + 6.572_6$$

Column Theor.	Column Obs.	
2.034	2.037	D
1.473	1.4674	D
	1.476	D

(72) Thomsonite $Ca + Al_2 + Si_2 + O_4 + O_4 + 2.5H_2O$ **2.32** 2.3-2.4 D

$$\mathbf{69.9707 = 0.50205(14.54 + 12.05_2 + 18.91_2 + 4.45_4 + 2.51_4 + 14.03_{2 \cdot 5})}$$ **1.50205** 1.503 D

$$\mathbf{69.970 = 10.52 + 4.863_2 + 10.461_2 + 1.747_4 + 1.346_4 + 6.572_{2 \cdot 5}}$$

The eight minerals containing beryllium are the only ones available, and the fact that the pair of values, 4.62 and 3.733, exactly fit in with previously demonstrated values of other elements as perfectly as if they were the two final pieces of eight jig-saw puzzles, proves that the 72 collinsics so far published contain the exact truth plainly written upon them.

THE TANNIN EXTRACT PLANT AT CRAWLEY, WESTERN AUSTRALIA.

By Prof. N. T. M. Wilsmore.

(*The erection of the tannin extract plant* described below was completed towards the end of the first half of the year 1928, and the plant has now heen put into operation. On the occasion of its opening, Professor Wilsmore prepared a brief account of the apparatus and machinery that it contained, and also of the work it was intended to undertake. That account is printed below. Further details of the co-operative agreement reached between the Council, the Forests Department of Western Australia, and the University of Western Australia, are given in the First Annual Report of the Council.)

Introduction.

The object of the plant is to investigate on a semi-technical scale the possibility of the commercial manufacture in Australia of tannin extracts from Australian raw materials.

The more important items of the plant were bought some years ago by the former Institute of Science and Industry on the advice of Mr. D. Coghill, the Institute's officer in charge of tannin investigations, but as funds at that time were insufficient to complete and erect the plant, the items that had been bought had to be stored in Melbourne. In 1926, shortly after the Institute had been reconstituted and become the present Australian Council for Scientific and Industrial Research (referred to as "C.S.I.R."), Mr. S. L. Kessell, Conservator of Forests, suggested that, as Western Australia is rich in potential raw materials for making tannin extract, the Forests Department might co-operate with C.S.I.R. *in defraying the cost of completing*, erecting, and running the plant, provided it were erected in Westedn Australia. This suggestion was approved by the State Government and by C.S.I.R., and a Committee, consisting of Mr. S. L. Kessell (Chairman), and Professors Whitfield and Wilsmore, was appointed by C.S.I.R. to take charge of the work.

With the consent of the Senate of the University of Western Australia, a site for the plant was selected on University land, adjacent to the boiler-house attached to the School of Engineering and Mining at Crawley, and it was agreed that steam for working the plant should be obtained from one of the University's boilers on condition that C.S.I.R. undertook to defray the cost of fuel, attendance, and incidental repairs to the boiler.

Raw Materials to be Studied.

Amongst the most abundant potential sources of tannin in Western Australia are karri bark (*Eucalyptus diversicolor*), marri kino from the marri or redgum tree (*Eucalyptus calophylla*), the bark of ridge gum (*Eucalyptus alba*), and various wattles and mangroves. Of these materials, karri bark is the most readily obtainable—at present thousands of tons of it are burned annually at the saw-mills in the karri country. Marri kino has the highest tannin content, but it has to be specially collected, and it requires chemical treatment to get the tannin permanently into solution.

Raw materials from the other Australian States will also be studied in the plant, one that seems promising being wattle tops from South Australia.

Process.

This will vary in details according to the material being treated. In general the raw material is first pulverised, and then leached with water—hot or cold, as needed —in a series of vats or "leaches." The weak liquor so obtained is concentrated in a two-stage evaporator, and converted into concentrated liquid extract, which, in turn, can be evaporated further in a "Kestner" dryer to give solid extract. As solutions of tannin turn black if they are allowed to act

on iron, all metal parts of the plant with which these solutions may come into contact must be made of brass, bronze, or copper.

BUILDINGS AND PLANT.

The main building, in which most of the plant is housed, is of corrugated iron on jarrah framing, and is 50 feet long by 25 feet wide, with walls 17 feet high, and a gable roof. Adjoining the main building are a shed 25 feet by 25 feet for storing bark and other raw materials, and a building 35 feet by 15 feet containing a chemical laboratory and office. The old Tiemann kiln, formerly used for experiments on the seasoning of timber, will also be used for storage.

Water for cooling purposes and for leaching is obtained by means of an electrically-driven centrifugal pump, capable of delivering up to 4,000 gallons per hour, from a well 4 feet by 4 feet by 32 feet deep, situated in one corner of the bark shed. Water from the town mains is also laid on for use in the laboratory and plant, and to supply a fire hydrant.

Steam is obtained from one of the Babcock and Wilcox boilers belonging to the University, wood being used as fuel. Steam at boiler pressure is used to drive the circulating pump of the leaching plant and the pumps of the two-stage evaporator, but steam for heating purposes is passed through a reducing valve to reduee its pressure to from 5 to 10 lb. per square inch above atmospheric pressure. Low-pressure steam is also supplied to the laboratory for heating purposes and to give a supply of distilled water. Electric current for motors and lighting is obtained from the mains of Perth.

Raw materials are pulversed in a Van Gelder combined crusher and disintegrator; and the ground material is then raised by means of a "Sirocco" dust-fan through a sheet-iron duct to a "Cyclone" separator mounted above the roof, in which the ground material is diverted from the air current by centrifugal action and allowed to drop into a storage bin. A tip-truck, running on rails along the loading platform, level with the tops of the leaching vats, is used to charge the latter with ground material taken from the storage bon. Spent material is shovelled over the tops of the vats into shoots leading it outside the building.

LEACHING PLANT.

Six leaching vats are provided, each vat having a total capacity of about 800 gallons, and holding normally about 6 cwt. of ground bark, and about 600 gallons of water. In each vat, the ground material is supported on a perforated false bottom of copper, covered with hessian. Beneath the false bottom is a steam coil for heating the contents of the vat. By means of suitable pipe lines and valves, water or liquor can be delivered to the top of each vat or drawn off from below. Liquor is moved from vat to vat, and to or from one or other of the various storage tanks, by a steam-driven duplex pump. This pump delivers through a pre-heater, which can be heated by steam when hot liquor has to be supplied to a vat. A second pump (belt driven) is also provided for moving liquor from one part of the plant to another.

Among the questions to be answered with the help of this plant for each kind of raw material to be tried are:—What is the most economical number of leachings per batch of material? And should leaching be done hot or cold? For karri bark four leachings seem likely to be satisfactory. This means that each batch of liquor will be passed in series through four vats filled with ground bark, and each vat full of bark will be leached four times, namely, first, with liquor which is not far from the maximum strength obtainable by leaching, and finally with fresh water. In normal working vats will be filled and emptied in regular sequence.

Five circular storage tanks, with floors and walls of concrete, have been built below floor level. The walls of these tanks form convenient foundations for other portions of the plant. In addition, three circular tanks of corrugated sheet-copper are mounted on the cross beams under the roof. A rain-water tank is mounted on a stand outside one end of the building.

TWO-STAGE EVAPORATOR.

This was supplied by Blair, Campbell, and McLean, Ltd., of Glasgow, as were also most of the metal parts of the leaching plant. Evaporation is carried out in two stages or "effects," each "effect" consisting of a steam-heated evaporator below and a separator or spray-catcher above. Liquor from the leaching plant is delivered from an overhead storage tank to a small feed tank, in which the level of liquor is kept constant by means of a float valve. From the feed tank, the liquor is admitted through a regulating valve first into a pre-heater, and from this into the first "effect" where evaporation s begun. It then passes into the second "effect," working at as low a pressure as possible, where evaporation is completed, the limit to which the con-

centration of the extract can be pushed being governed by the condition that the concentrated extract must not be too viscous to flow through pipes. The concentrated liquid extract is removed from the second " effect " by means of an extraction pump, which delivers it into another of the overhead storage tanks. The pre-heater and the first " effect " are heated by steam from the boiler, the water formed by the condensation of this steam being drained off through " steam traps." The second " effect " is heated by means of the steam produced from the boiling of the liquor in the first " effect." The steam from the boiling liquor in the second " effect " passes from the separator of that " effect " into a surface condenser and then into a steam-driven " wet vacuum " pump. In steady running all the condensed water from the evaporator will be available for leaching. It will be seen that, by this arrangement, the latent heat of the boiler steam is used twice over. Under ideal working, for every 1 lb. of boiler steam condensed, 2 lb. of water should be boiled off from the liquor. In actual practice, however, the efficiency is much less, owing to various losses of heat. Also, steam is needed to drive the vacuum and extraction pumps. Since evaporation takes place in both " effects " under reduced pressure, the temperature of the liquor is kept well below the normal boiling point of water. This is important, as some tannins decompose at higher temperatures. The evaporator is designed to deal per eight-hour shift with about 600 gallons of liquor from the leaching plant.

The object of this apparatus is to complete the evaporation of the concentrated liquid extract down to solid extract, containing not more than from 10 to 15 per cent. of water. A bronze cylinder or drum, heated internally by steam from a boiler, revolves slowly on a horizontal axis. The drum dips into a trough fed with concentrated liquor, and as the drum revolves it picks up a thin film of the liquor, which, after about three-quarters of a revolution, becomes solid extract. The latter is removed continuously from the drum by scrapers, and falls into a hopper where it is broken up by means of an Archimedean screw, and passed into a discharging device, and thence into bags or other containers.

Evaporation can be carried out in the open air, or, alternatively, the drmu can be enclosed in an airtight case, which can be exhausted by a suction pump for evaporating under reduced pressure.

There is an autoclave, a closed vessel of copper, which can be heated by live steam. It is intended, primarily, to get into solution the tannins from marri kino, which requires heat and addition of sodium bisulphite. The autoclave can be worked at atmospheric pressure, or at a wide range of pressures either above or below atmospheric. For working under reduced pressure a " dry-vacuum " pump is provided.

From time to time, University students in chemistry and engineering will have opportunities, especially during University vacations, to assist in running the plant, and thereby to acquire some first-hand knowledge of chemical technology.

THE PROGRESS OF PULVERISED FUEL IN GERMANY.

One of the chief characteristics of the Continental power stations running on pulverised fuel, visitied by Mr. G. H. Lake, Chief Electrical Engineer of Derby, was the remarkable cleanliness of the stations fired on this system. A perusal of the report issued by him reveals the fact that high pressure plants are now in fairly general use throughout Germany.

Summarising the information on this point of pressure we find that a boiler at the works of A. Borsig is operating at 900 lbs. per sq. in., the Bonson Boiled at Siemens-Schuckert is operating at 3,375 lbs., fired on the " Lopulco " system, 16 boilers at the Klingenberg power station are operating at 500 lbs., boilers at the Leuna works are working at 675 lbs. pressure, at a works at Oppau the boiler pressure is 680 lbs., and at the electricity works at Mannheim vertical-tube boilers are operating at 1,500 lbs., also fired on the " Lopulco " system.

It is clear also that the dust problem is practically solved, German engineers having in their usual efficient manner given very close and continuous attention to this and other items associated with pulverised fuel firing. It is gratifying to learn that the British device invented by Davidson & Son is being adopted in power stations on the Continent, and that this type of dust collector installed at Derby shewed on tests an efficiency of 86.5 per cent.

KING'S COLLEGE CENTENARY.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,—During the present academic year King's College, University of London, will celebrate the hundredth anniversary of its foundation, and upon this occasion we desire strongly to commend the urgent needs of the College to the generous consideration of your readers.

The proposal to found the College was first made at a meeting held at the Freemason's Tavern on 21 June, 1828, under the chairmanship of the Duke of Wellingtou; and King's College received its Royal Charter of incorporation on 14 August, 1829. King George IV, as Patron, made the grant of the present site in the Strand, adjoining Somerset House, where for a century the College has carried on its ever-growing activities.

Before the War the full-time day students in attendance at the College numbered about 700. To-day there are more than 1,200 undergraduate students in the six Faculties of Arts, Science, Engineering, Medicine, Laws and Theology; over 300 post-graduate students are reading for higher degrees or are otherwise engaged in research work; and some 500 students who would otherwise be unable to obtain a University education are reading for degrees and diplomas in the Evening Department specially provided for those unable to attend during the day. Another new and important development since 1913 has been the annual scheme of free public lectures by means of which the latest discoveries in science and learning have been made accessible to large popular audiences.

This increase in numbers and the modern requirements of teaching and research are making new demands which must be met. Among the most pressing needs are the construction of a new Anatomy Building in proximity to the Physiological laboratories and the reconstruction and extension of the Chemical laboratories in the block of buildings overlooking the Temple Station.

Further, the work of the College is seriously hampered by lack of endowments. Indeed, the proportion of income derived from permanent endowments is smaller than that of any other University Institution in the British Isles. Of a total annual expenditure of over £130,000 not more than £4,800 is at present derived from endowments for Chairs, Scholarships and Research.

We ask for a total sum of £350,000. Of this £125,000 is required for the new buildings for science and medicine; £15,000 for a new wing of the Hostel in Vincent Square; £125,000 for the endowment of Chairs of English Language and Literature, Physics, Physical Chemistry, Electrical Engineering, and Physiology; £25,000 for Chairs in the Theological Department; and £60,000 for Scholarships and Bursaries.

Proud of our record during these hundred years, we appeal with confidence to the citizens of London and Westminster and to all friends of higher education to enable King's College to enter upon its second century equipped with buildings and endowments comparable with those of the provincial Universities, which owe so much to the enlightened support of generous benefactors, and not unworthy of such an institution established in the capital of the Empire.

Donations, large or small, can be sent to one of the Treasurers, the Right Honourable Reginald McKenna, or Sir Edward Troup, K.C.B., K.C.V.O., at King's College, Strand, W.C.2., or to the College Bankers, Messrs. Coutts and Co., at 440, Strand, W.C.2., for the credit of King's College Centenary Appeal Account. Copies of a detailed statement of the more urgent needs of the College may be obtained upon application to the Secretary, King's College.

Yours, etc.,

ROSEBERY, *Chancellor of the University of London.*

RANDALL CANTAUR, *Visitor of King's College, London.*

ULLSWATER, *Chairman of King's College Centenary Commemoration Committee.*

C. A. BATHO, *Lord Mayor of London.*

JACQUES ABADY, *Mayor of the City of Westminster.*

R. MCKENNA, *Treasurer, Centenary Appeal Fund.*

EDWARD TROUP, *Treasurer, Centenary Appeal Fund.*

W. R. HALLIDAY, *Principal.*

W. R. MATTHEWS, *Dean.*

King's College,
Strand, W.C.2.
20 October, 1928.

THE INSTITUTE OF LINGUISTS.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,—Last year a Forward Movement of the Institute of Linguists was launched by the President for that year, W. Lacon Threlford, Esq., M.B.E., F.C.A., with a

gift of £100, and he now offers to renew this gift on condition that 99 others make a similar gift.

The Institute of Linguists was originally founded in 1910, but lapsed at the outbreak of the Great War. It was restarted in 1923 and has now enrolled many hundreds of British linguists, carefully classified according to linguistic ability as Fellows, Associates and Registered Students; has issued for four years its official organ *The Linguists' Review*, in six languages; examined many hundreds of candidates, published a guide to its examinations, established an Employment Bureau, a Linguistic Enquiry Bureau, gathered together the nucleus of a Foreign Lending Library, and established brauches in many centres for foreign lectures and causeries.

Many well-known Educationalists and commercials magnates have expressed appreciation of the aims of the Institute and Sir Henry Hadow, Vice-Chancellor of Sheffield University and Sir Harold Bowden of the Raleigh Cycle Company are Vice-Presidents.

The War has largely thrown Great Britain back on her own resources as regards foreign languages and her foreign trade urgently needs a larger supply of efficient linguists of British birth. One of the many objects of the Institute is to encourage a combination of salesmanship and linguistic proficiency, so that the foreign traveller seeking orders for British goods should not only be efficient as a salesman, but also as a linguist.

To make this possible, the undersigned are issuing this public appeal for support, so as :

(1) To establish Headquarters in London with reading room and other facilities, which such a central Bureau could offer for the study of modern languages.

(2) To open branches for foreign lectures and causeries in every important centre and to co-ordinate the valuable work of many local societies with the policy of the National Movement.

(3) To extend its examinations, so as to cover all languages used in British commerce.

(4) To establish a fund for awarding suitable prizes and scholarships to those showing linguistic ability, so as to enable them to perfect their knowledge by residence abroad.

Messrs. Barclays Bank, Ltd., have kindly promised to receive donations sent in response to this appeal at: Barclays Bank, Head Office, 54, Lombard Street, London, E.C.3.; and Barclays Bank, Meadows Branch, Nottingham.

Yours truly,

LLOYD STORR-BEST,
President.

105, Loughborough Road,
West Bridgford,
Nottingham.
22 October, 1928.

GENERAL NOTES.

TWO BRITISH COLUMBIA MINES.

The British Columbia Chamber of Mines has forwarded to the High Commissioner for Canada in London reports on two mining properties in Kamloops, B.C., at which encouraging results have recently been achieved, and which it is desired to bring to the attention of British investors.

The properties in question are the Cotton Belt Mines in the Seymour River area, 6,000 feet above sea level at the head of Shuswap Lake, and the Meadow View gold-quartz property which has recently been added to and controlled by Cotton Belt Mines, Ltd.

Copies of the Reports in question can be consulted by persons interested on application at the Canadian Building, Trafalgar Square, London, S.W.1.

PROGRESS OF THE STEAMING ECONOMISER.

Six months ago the steaming economiser was first introduced in steam raising in this country, when six Foster steaming economisers were ordered for the power plant of Synthetic Ammonia and Nitrates, Ltd., Billingham. Since that date the same type has been adopted by Leicester Corpo... Electricity Department for the new L... ter power station. Now the Derby Cor... tion Electricity Works in which three... heating Foster economisers have been ... stalled, has placed an order for two stea... economisers for the new extension to ... power plant at Derby. The appar... which is made by Green's of Wakefiel... Eco Power Ltd., embodies in its const... tion a solid drawn steel tube on which ... shrunk machined cast iron gilled rings, ... embodying the pressure resistance of st... with the corrosion resistance of cast iro...

CANADIAN FUEL RESEARCH REPORTS.

The Mines Branch of the Dominion Department of Mines has just issued Report No. 689 containing details of Investigations on Fuels and Fuel Testing carried on at the Research Laboratories in Ottawa during the year 1926.

The report opens with a general review of investigations by Messrs. B. F. Haanel and R. F. Gilmour, and in Part I are bound up the following reports on investigations into coal, coke and peat :—

1. Instructions for Burning Coal, Coke and Peat. By E. S. Malloch and C. E. Baltzer.

2. Low-Temperature Carbonisation — Continuation of Tests on Canadian Bituminous Coals. By R. A. Strong.

3. Study of the Nature of Sulphur in Canadian Coal and Coke. By J. H. H. Nicholls.

4. Air-Drying of Canadian Lignite, and the Reabsorption of Moisture by the Same. Bq J. H. H. Nicholls.

5. Analyses of Solid Fuels. Compiled by J. H. H. Nicholls.

Part II contains particulars of investigations into oil fuels, a list of which is given below :—

1. Gasoline Survey for 1926. By P. V. Rosewarne and A. F. Gill.

2. Report of Experiments on the Dehydration of Bitumen Emulsion from Alberta Bituminous Sands. By P. V. Rosewarne and G. P. Connell.

3. Oil Shale from Rosevale, New Brunswick. Bp A. A. Swinnerton.

4. Report on the Pritchard Process for the Distillation of Oil Shale. By R. E. Gilmore and A. A. Swinnerton.

5. Canadian Shale Oil and Bitumen from Bituminous Sands as Sources of Gasoline and Fuel Oil, by Pressure Cracking. By R. E. Gilmour, P. V. Rosewarne and A. A. Swinnerton.

Copies of the report may be obtained by persons interested on application either to the Department of Mines at Ottawa or to the Office of the High Commissioner for this ada, The Canadian Building, Trafalgar re, London, S.W.1.

RAPID CONSTRUCTION OF FLIN FLON POWER PLANT.

The contract for hauling materials required by the owners of the Flin Flon mines for the construction of its 39,000 h.p. generating plant at Island Falls on the Churchill River, 65 miles northwest of the mine, has been awarded.

It is estimated that 30,000 tons of material of all descriptions must be taken in over the winter roads and delivered at the power site by March 31, 1929. This is believed to be one of the largest winter haulage contracts ever let in Canada. All of the material will go by the nearly completed Manitoba Northern Railway as far as Flin Flon Mine, where it will be transferred to sleighs for its journey to the Island Falls site. A small army of men, nearly 200 teams of horses and many motor tractors will be engaged in the operations. The initial work includes the erection of warehouses at the end of the railway and at Island Falls, and also camps for the accommodation of men and horses. The motor tractors to be used will have a freight capacity of 50 tons and no difficulty is anticipated in locating the road and delivering the material.

ANOTHER INDUSTRIES FAIR RECORD.

WORLD BOOKINGS FOR THE ROYAL FILM.

Bookings of stand space in the London section of the British Industries Fair, to be held at White City from February 18 to March 1, have exceeded the record figure of 257,000 square feet at the last Fair. This means that both the London and Birmingham sections will be larger than ever before, the Birmingham bookings having exceeded the previous figures some time ago.

The space booked in the two sections by the Dominions and Colonies for the display of raw materials and manufactured products is more than double that occupied last February.

Copies of the film taken at the last British Industries Fair, in which the King and Queen are the leading figures, have now been despatched by the Department of Overseas Trade, for exhibition before the opening of the next Fair, to Australia, New Zealand, Canada, Sweden, Italy, Turkey, Belgium, Switzerland, Portugal, Dutch East Indies, Colombia and Portuguese East Africa.

The film is also available now for exhibition at home.

INTERFEROMETER MEASUREMENTS OF WAVE LENGTHS IN THE VACUUM ARC SPECTRA OF TITANIUM AND OTHER ELEMENTS.

By C. C. Kiess (U.S. Bureau of Standards).

Wave-length determinations by means of the Fabry-Perot interferometer have been made for the vacuum arc spectrum of titanium. More than 300 lines have been measured between 6743 A in the red and 2941 A in the ultra-violet. For many of the lines the accuracy of measurement exceeds 1 part in 6,000,000; for the majority it exceeds 1 part in 4,500,000. Using only the wave numbers of lines of wave lengths longer than 4700 A, and constant wave-number differences as determined in various parts of the spectrum, a set of terms has been derived, which have been used to calculate the wave lengths of the blue and violet lines. The comparison of calculated with observed wave lengths indicates that no difference in scale exists between the red and violet regions. In addition to titanium some wave lengths were measured for iron, copper, calcium, barium, and other elements.

Proceedings and Notices of Societies

THE PHYSICAL SOCIETY.

A meeting was held on Friday, October 26, at the Imperial College of Science. The following papers were read :—

" An Experimental Study of the Anticlastic Bending of Rectangular Bars of Different Cross-Sections." By Allan Ferguson, M.A., D.Sc., and Jas. P. Andrews, M.Sc.

" An Instrument for the Production of Known Small High-Frequency Alternating Electromotive Forces." By B. S. Smith, A.M.I.E.E., F.Inst.P., and F. D. Smith, M.Sc., A.M.I.E.E.

A Demonstration of a New Device for Thermostatic Control was given by H. F. T. Jarvis, B.Sc., Birkbeck College.

THE PHYSICAL AND THE OPTICAL SOCIETIES.

Nineteenth Annual Exhibition.

The Nineteenth Annual Exhibition of Electrical, Optical and other Physical Society and the Optical Society on January 8, 9, and 10, 1929, at the Imperial College of Science and Technology, South Kensington.

As on previous occasions the Exhibition will be divided into a Trade Section, comprising the exhibits of manufacturing firms, and a Research and Experimental Section. The preliminary invitation to trade exhibitors has already been issued, and entries have been asked for by October 27. The Exhibition Committee invites offers, from Research Laboratories and Institutions and from individual research workers, of exhibits suitable for inclusion in the Research and experimental Section. The exhibits in this section will be arranged in three groups :

a. Exhibits illustrating the results of recent physical research.

b. Lecture Experiments in Physics.

c. Historical exhibits in Physics.

Accommodation for these exhibits will be provided in rooms separate from those devoted to the trade exhibits; and a part of the Catalogue will be devoted to their description. No charge will be made for space or catalogue entries in the Research and Experimental Section, and the facilities of the Imperial College will be at the disposal of the exhibitors.

Offers of exhibits for inclusion in any of the above three groups should be communicated immediately, and in any case not later than November 14 to the Secretary, Physical and Optical Societies, 1, Lowther Gardens, Exhibition Road, London S.W.7. Brief particulars of space and other facilities required should be given.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

September Examinations, 1928.

Pass List.

Examination for the Associateship :

In General Chemistry :

Davis, Miss Joan, B.Sc. (Lond.), King's College, London; Evans, Cyril Harry, The Technical College, Leeds; Ferguson, George William, Sir John Cass Technical Institute, London, and Birkbeck College, London; Ford, Victor Gerald, B.Sc. (Lond.), The West Ham Municipal College; Hartley,

Sidney, A.M.C.T., The College of Technology, Manchester; Jones, Ronald Henry, University College, and The Technical College, Cardiff; Keightley, Walter Maurice, University College, Nottingham; Lauwerys, Joseph Albert, B.Sc. (Lond.), Trained under the Head of the Chemistry Dept., Municipal College, Bournemouth.

In Branch (*a*) : *Mineral Chemistry* :

Wood, Alexander, Heriot-Watt College, Edinburgh, and Chelsea Polytechnic.

In Branch (*g*) : *Chemical Technology* :

Pulsford, Arthur Donald, Battersea Polytechnic, London.

Examination for the Fellowship :

In Branch E : *The Chemistry, including including Microscopy, of Food and Drugs, and of Water.*

Firth, Herbert; Jones, Archibald Orton, M.A. (Oxon.); Klein, Ralph Harry; Lucke, Douglas Thurlow, B.Sc. (Lond.).

In Branch G : *Industrial Chemistry* :

Munro, Reginald James, B.Sc. (Glas.), A.R.T.C.

SOCIETY OF CHEMICAL INDUSTRY.

MANCHESTER SECTION.

His Majesty the King has been graciously pleased to grant his patronage to the Annual General Meeting of the Society of Chemical Industry, which is to be held in Manchester from July 8 to the 13, 1929.

The Society met in 1928 in New York, a large and representative party from England visiting Canada and the United States on this occasion.

It is anticipated that many prominent and influential people will accompany Dr. Little, the American President of the Society, on his visit to attend the Annual General Meeting in Manchester.

Any information relative to the meeting can be obtained from the Hon. Local Secretary, Society of Chemical Industry, College of Technology, Manchester.

NOTICES OF BOOKS.

Wave-Length Measurements in the Arc and Spark Spectra of Hafnium. By W. F. MEGGERS, U.S. Bureau of Standards. Pp. 87. Sold only by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 1928. Price 15 cents.

In this reprint the following summarises the features dealt with :— Using the purest available samples of hafnium salts the arc and spark spectra characteristic of this element were photographed with concave-grating and quartz-prism spectrographs. Wave-length measurements were made on about 2,100 lines, but 609 of these were discarded as impurities, identified mainly as columbium, zirconium, and titanium. Nearly 1,500 lines remain to describe the hafnium spectra between the wave-length limits 2155.72 A in the ultra-violet and 9250-27 in the infra-red. In this investigation an attempt has been made to improve upon an earlier description of these spectra, (1) by extending observations to shorter and to longer waves, (2) by increasing the precision of the wave-length measurements to ± 0.01 A, and (3) by making a more critical differentiation between lines characterising neutral atoms (Hf I) and those ascribable to ionised atoms (Hf II). Comparison of these results with the earlier measurements of zirconium spectra proves that hafnium was invariably present as an unrecognised impurity. The most sensitive Hf I and Hf II lines for spectro-chemical identification are tentatively selected. The stronger Hf II lines are identified with faint Fraunhofer lines in the sun's spectrum.

Glycerol and the Glycols. By J. W. LAWRIE, Ph.D. Pp. 447. New York : The Chemical Catalog Co. 1928. Price $9.50.

Glycerol was discovered in 1784 by Scheele, who probably prepared more new substances than any investigator before his time or since. His " sweet principle of fats " was called glycerol by Chevreul in 1811 who made an exhaustive study of fats and showed their true nature. Later methods for extracting it from fats as the demand increased have continued to this day. The production and use of glycerol has now assumed such proportions that Dr. Lawrie's account of them is particularly welcome. That other polyhydric alcohols (glycols) are also made and used in increasing quantities has led to their inclusion in the present monograph of the series issued by the American Chemical Society.

The volume gives a comprehensive account of the chemistry and manufacture of these substances and some of their important derivatives and will be of service to those concerned industrially or otherwise, with these important compounds.

The current issue (September, 1928) of BUILDING CONSTRUCTION is a Roads and Bridges number, and gives some facts and figures of quite unusual interest. An article, *Roads for the Million*, is based on a recent address deliverel by Sir Henry Maybury, of

the Ministry of Transport. He called for strong, safe and straight roads (obviously concrete roads) and deprecated the number of accidents that took toll of life and health. He urged that greater attention should be given to the slippery conditon of the surfaces of the roads, and to the faulty reinstatement of trenches, or the lack of repair of some individual section of the surface.

PUBLICATIONS RECEIVED.

U.S. DEPARTMENT OF COMMERCE.

One-piece Porcelain Insulators. 5c.
Standard Conversion Time Chart. 10c.
Master Specification for Packing-Flax.
Master Specification for Integral Waterproofing Material.

Forthcoming Events.

MINERALOGICAL SOCIETY.

Tuesday, November 6, at 5.30 p.m.—Anniversary Meeting. F. A. Bannister: "The So-Called 'Thermokalite' and the Existence of Sodium Bicarbonate as a Mineral." W. A. Wooster: "The Piezo-Electric Effect of Diamond." F. N. Ashcroft: "An Exhibit of Minerals Recently Collected in Switzerland."

THE ROYAL INSTITUTION OF GREAT BRITAIN.

Tuesdays, October 30, November 6, 13, at 5.15 p.m.—"Co-aggregation *versus* Continuity in the Change of State from Liquid to Vapour." By H. L. Callendar, C.B.E., LL.D., M.A., F.R.S., Professor of Physics, Imperial College of Science. (The Tyndall Lectures.)

Tuesdays, November 20, 27, December 4, 11, at 5.15 p.m.—"Diamonds." By Sir William Bragg, K.B.E., LL.D., F.R.S., M.R.I. Fullerian Professor of Chemistry.

Thursdays, November 1, 8, 15, at 5.15 p.m.—"The Clash of Culture." (1) Race and Culture; (2) Culture-Clash in a Maori Village; (3) The Empire and the Native Problem. By Captain G. Pitt-Rivers, B.Sc.

Thursdays, November 22, 29, at 5.15 p.m.—"The Mechanism of the Nerves." By E. D. Adrian, M.D., F.R.C.P., F.R.S. Lecturer in Physiology, University of Cambridge.

Thursdays, December 6, 13, at 5.15 p.m. —"Human Speech as (1) A Method of Expression by Gesture; (2) A Musical Phenomenon: Some Conclusions." (With experimental demonstrations). By Sir Richard Paget, Bart., F.Inst.P., M.R.I.

Saturdays, November 3, 10, at 3 p.m.—"Recent Observations and Discoveries Respecting the Planets." By Rev. Theodore E. R. Phillips, M.A., F.R.Met.S., President of the Royal Astronomical Society.

Saturdays, November 17, 24, December 1, at 3 p.m.—(1) and (2) "North Country Folk Music; (3) The Violin Sonatas of William Young (17th Century)." By William G. Whittaker, D.Mus. Reader in Music and Conductor, Armstrong College, Newcastle-on-Tyne. (With musical illustrations.)

Saturdays, December 8, 15, at 3 p.m. "The Gulf Between Painter and Public." By Walter Bayes, A.R.W.S., Head of Westminster School of Art.

JUVENILE CHRISTMAS LECTURES.

December 27, 29, 1928, January 1, 3, 5 and 8, 1929, at 3 p.m.—"Sound Waves and Their Uses." By Alexander Wood, M.A. Tutor of Emmanuel College and Tutor in Physics, University of Cambridge. One hundred and third course adapted to a Juvenile Auditory (illustrated by models and experiments).—(1) Waves, December 27; (2) Signalling in Air and Water, December 29; (3) Notes and Noises, January 1, 1929; (4) How Sounds are Analysed, January 3; (5) he Ear and What it Does, January 5; (6) How Sounds are Recorded and Reproduced, January 8.

ROYAL SOCIETY OF ARTS.

175TH SESSION, 1928-29.

Wednesday, November 7, at 8.30 p.m.—(Inaugural Meeting). Sir George Sutton, Bt., Chairman of the Council of the Society: "Fifty Years of British Industry."

Friday, November 9, at 4.30 p.m.—(Indian Meeting.) James Welby Madeley, M.A., M.Inst.C.E.: "Town Water Supply in India." Sir Hugh Trowbridge Keeling, C.S.I., will preside.

Monday, November 12, at 8 p.m.—(Cantor Lecture.) Franklin Kidd, M.A., D.Sc., Principal Assistant, Low Temperature Research Station, Cambridge: "Refigeration." (I)

Wednesday, November 14, at 8 p.m.—(Ordinary Meeting.) Omar Ramsden, R.M.S. : " English Silver and its Future." The Rt. Hon. the Earl of Crawford and Balcarres, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, November 7, at the Chemical Society's Rooms, Burlington House, at 8 p.m. The following papers will be read :—

" Improved Method for the Determination of Small Quantities of Antimony in the Form of Stibine." By Julius Grant, M.Sc., A.I.C.

" Analysis of Small Samples of Gas." By H. R. Ambler, B.Sc., A.I.C.

"Determination of Unsaponifiable Matter in Oils and Fats." By E. Lester Smitb, M.Sc., A.I.C.

" Composition of Irish Butter." By Paul Arup, M.Sc., F.I.C.

" Volumetric Determination of Mercury." By H. B. Dunnicliff, M.A., Sc.D., F.I.C.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Belfast and District Section.

Programme for Session 1928-29.

Generally the Meetings will be held in the Physics Lecture Theatre of the Belfast Royal Academical Institution and will commence at 7.30. Otherwise members will be specially notified.

Thursday, November 22, 1928.—Annual Dinner.

Thursday, January 24, 1929. — " The Recently Discovered Elements." By Dr. J. K. Marsh.

Wednesday, February 27. — " The Botanist and the Flax Plant." By Mr. G. O. Searle.

Tuesday, March 26.—" X-Ray Demonstration." By Dr. Allworthy.

Wednesday, April 24.—Works Visit.

Friday, May 17.—Annual General Meeting.

The Committee extend an invitation to visitors interested in Chemistry to attend meetings of the Section.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,366.—Bataafsche Petroleum Maatschappij.—Purification of sulphonic acids, etc. October 11th.

29,377.—Boot's Pure Drug Co., Ltd., and Marshall, J.—Production of monohydric phenols. October 11th.

29,342.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of solutions of 2 : 3-hydroxynaphthoic acid arylides. October 11th.

29,123.—Vereinigte Glanztoff - Fabriken Akt.-Ges.—Separatiou of sodium sulphate from sulphuric acid. October 10th.

Specifications Published.

298,108.—Harter, H.—Apparatus for carrying out chemical reactions between gases, or vapours, or gases and vapours.

298,389.—Reckitt & Sons, Ltd., and Whitaker, R. J.—Packing chemical and other tablets.

298,393.—Edelman, S.—Production of a derivative of 1-methyl 3-oxy 4-isopropyl benzene.

286,694.—I. G. Farbenindustrie Akt.-Ges. Manufacture of 6-nitro-2-amino-1-benzoic acid.

298,122.—I. G. Farbenindustrie Akt.-Ges.—Alloys resistant to chemical action.

Abstract Published.

296,074.—Potassium manganate. — Soc. Chimique Des Usines de Rhone, 21, Rue Jean-Goujon, Paris.

In the process described in the parent Specification, caustic potash lyes, containing 50 per cent., instead of 60-80 per cent., potassium hydroxides or thereabouts may be used for the preparation of potassium manganate without using an excessive rate of flow of air or oxygen, provided that the temperature used is raised above 200° C., preferably between 210° and 220° C.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

REGELAX.

489,454.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street Nottingham. October 10th.

ICENIA.

493,810.—Chemical substances prepared for use in medicine and pharmacy.—Hedges (Chemists) Limited, 10, Dale End, Birmingham. October 10th.

THYANGOL.

493,331.—All goods in Class 3 which includes chemical substances prepared for use in medicine and pharmacy. —Julius Thilo, trading as Dr. Thilo & Co., 15, Weisenaustrasse, Mainz, Germany. October 10th.

495,160.—The word REFISTINE and the initials A.A.J.M. for chemical substances prepared for use in medicine and pharmacy. — Andre Adriaan Johannes Moelaart, 20, Rue du Conseil, Ixelles, Brussels, Belgium. October 17th.

CHEMIST REQUIRED.

Required, a Chemist to supervise an OIL MILL AND SOAP FACTORY in India. Only those with considerable practical experience in both Oil Milling and Soapmaking need apply. Preference will be given to those holding a Degree or Diploma. Good prospects to suitable applicant.

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PATENT LICENCES.

The Owners of Patent No. 222461 relating to

"APPARATUS FOR THE SYNTHETIC PRODUCTION OF AMMONIA AND ITS ELEMENTS,"

are desirous of negotiating with Interested Parties for the granting of Licences thereunder on reasonable terms. For information apply to Messrs. LLOYD WISE & Co., Chartered Patent Agents, 10, New Court, Lincoln's Inn, London, W.C.2.

THE CHEMICAL NEWS
AND JOURNAL OF INDUSTRIAL SCIENCE.

Founded in 1859 by Sir William Crookes, O.M.

Published every Thursday.

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THE CHEMICAL NEWS

VOL. CXXXVII. No. 3578.

MERTON HOUSE, SALISBURY SQUARE,
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ORIGIN OF THE HESS-KOLHÖRSTER RADIATION—COSMIC RAYS.*

The object of this article is to give the gist of Millikan and Cameron's latest developments, the subject being one of first importance.

I will quote these authors' abstract of their own paper which appeared in the *Physical Review* for October, 1928 :—

Maximum energy released by atomic-disintegration (radioactivity). — From Einstein's equation $Mc^2 = E$ and Aston's curve the maximum possible energy that can be released in radioactive changes can be computed. The theoretical and experimental values are in satisfactory agreement.

Energy released in step-by-step atom-building.—No step-by-step atom-building process can produce rays as penetrating as the observed cosmic rays. The absence of the radiations corresponding to such step-by-step processes probably means that atom-building does not in general occur in this way.

Creation of helium out of hydrogen.—About 80 per cent. of the observed cosmic rays appear to be due to the act corresponding to the sudden union of four positive and two negative electrons into [to form] the nucleus of the atom of helium. This produces a cosmic ray of absorption coefficient $\mu = 0.30$ per metre of water.

Creation of oxygen and silicon out of hydrogen.—The observed cosmic rays of absorption coefficients $\mu = 0.08$ and $\mu = 0.04$ appear to be produced by the sudden building of positive and negative electrons into atoms of oxygen and silicon, the former act giving rise to a ray of absorption coefficient $\mu = 0.08$, the latter to $\mu = 0.04$. This last is a definitely observed ray having an energy corresponding to the fall of an electron throught 216,000,000 volts.

Possible rays due to the creation of iron and to the annihilation of hydrogen.—The cosmic-ray indications are reconcilable with the view that iron is produced by the union in a single act of positive and negative electrons into [to form] the atom of iron, but the cosmic rays show no direct indications of the transformation of the whole mass of the hydrogen atom into radiation.

Synthetic cosmic-ray curves.—The observed cosmic-ray curve can be built up fairly satisfactorily by the assumption that the relative intensities of the cosmic rays reaching the earth's atmosphere are proportional to the abundance of the common

* This title is taken to make it differ from that of Millikan and Cameron in the *Physical Review;* also to call attention to the fact that the original work was not done by Millikan and his coworkers, but these investigators have so extended our knowledge of the subject that one sometimes hears the expression *Millikan rays.*

elements in meteorites and the earth's crust, 96 per cent. of these bodies being made of the four elements, oxygen, magnesium, silicon and iron.

Kinetics of atom-building.—While the kinetics of atom-building are more bothersome than the thermodynamics, with suitable assumptions, presented herewith, they *may not offer wholly insuperable difficulties.*

Place of origin of the cosmic rays.—Evidence is presented to show that cosmic rays do not originate in the stars, but only in the depths of space where temperature and densities are practically zero.

Cosmic rays and the Second Law of Thermodynamics.—The observed properties *of cosmic rays, indicating that the* creation of the common elements occurs only in interstellar or intergalactic space, suggest the possibility of avoiding the "warme-tod," and of regarding the universe as already in "the steady state."

Discussing the above and augmenting with explanatory matter—in 1905 Einstein showed that, as a consequence of his theory of relativity, a change of energy (δE) in any system involved a change in mass (δM) equal to this energy change divided by the square of the velocity of light—*i.e.*, $\delta E/c^2 = \delta M$—and as a consequence of this change there would, with a loss of mass, appear *radiant energy according to the equation*—$c^2\delta M = \delta E$.

This is expressed in ergs per second when the rate of energy emission is given. Calling this Einstein's mass-energy theory, it practically reduces to this :—If a mass disappears, it must disappear at the speed of light if it (mass) is converted into radiation. Now energy involves the square of the velocity. Therefore, Mass × Velocity of Light Squared = Energy in Ergs, which is Einstein's Equation, C.G.S. units being used.

In the case of "the emission of radiation by a star, or any other body, at the rate of E ergs per second, this necessarily involves a loss to the mass of the radiating body at the rate of E/c^2 grammes per second" to use Jeans' words here. This is implied above, but it helps to fix the idea.

Now if hydrogen of atomic weight 1.00778 combines in a fundamental manner with itself to form helium of atomic weight 4.00216, there is a disappearance of mass equal to the difference between 4H and He which is 0.029 grammes, on the gramme-atom basis. Since this mass disappears an appropriate amount of radiation energy must be given off, which, if the process is going on continuously, would be $0.029 \times c^2$ ergs per second. This is a very large power for so small a continuous supply of mass. 4 hydrogen atoms would always come together at the same instant, and this would continue to happen with fresh hydrogens, and so on continuously.

An amount of energy (δE) corresponding with a decrement of mass multiplied by c^2 is indicated above; but, in some cases the *entire* mass of hydrogen might disappear, as when its electron *completely* neutralises its positive charge or component. In this case the energy given out would be much greater, as the above equation indicates, namely, $1.00778 \times c^2 = E$.

It is a moot point whether in all ordinary chemical actions a loss of mass occurs according to Einstein's law. It would be too small to measure, as a simple calculation, with the above equation, shows. Even when a candle gives off radiation there may be an ultra-microscopic loss of mass in the atoms entering into the combination.

Attention has been concentrated on a *loss* of mass. If, conversely, there is a gain in mass there would be an appropriate *absorption* of energy.

It may be that in nature's laboratory, *which to us is largely a secret department,* this process is reversible, and consequently elements, or in particular electrons and protons, are formed out of radiation, an idea which has been discussed from time to time. If such be the case, then, while the stars are melting away in radiation, protons and electrons may be formed from this radiation in the cool depths of space, while these in turn build up into the abundant elements according to Millikan and *Cameron's recent views based upon their* extensive experiments. This building-up gives rise to the cosmic rays which are the "birth cries" of the elements.

Millikan and Cameron seem to advocate this complete process as sketched above, so that the atom-building process involves only a loss of a fractional part of the mass; whereas, the stars are "hot spots," due to the complete annihilation of electrons and protons in the centres of these hot spots, as *so strongly advocated by Jeans, and described* in these columns on several occasions.

The next step is to take the data and tools of theory available and see what the computations yield according to the procedure laid down by Millikan and Cameron.

(*To be continued.*)

THE GUTZEIT TEST

By A. D. Comrie, B.Sc., and T. J. Ward.

The purpose of this paper is to present a brief history of the well-known Gutzeit test for arsenic, and its application to the examination of brewing materials.

Some 50 years ago an account of the "Gutzeit-Fluckiger" test, in which paper impregnated with silver nitrate was used for the detection of small amounts of arsenic, antimony and phosphorus, was first published (*Pharm. Z.*, 1879, 263). Attention was directed to the use of this test, together with others, during the arsenic troubles of 1900, and various investigations were carried out with the object of rendering it suitable for reliable quantitative estimations. Thus, Harvey (*Chem. and Drug.*, 1905, 168) found it essential that the evolved gases must not be dry on coming into contact with the sensitive paper. Goode and Perkin (*J. Soc. Chem. Ind.*, 1906 xxv, 507) were among the first to suggest that the method by reason of its simplicity and economy of time might be used to supersede the Marsh-Berzelius method as a sorting test for the detection of more than a certain minimum amount of arsenic. Sanger and Black (*ibid.*, 1907, xxvi, 1115-1123), after an exhaustive examination of the method, and careful standardisation of experimental details, and Allen and Palmer (*Analyst*, 1912, xxxvii, 579) stated definitely that they had found the method to be as accurate as the Marsh-Berzelius test. Later, Hollins (*J. Soc. Chem. Ind.*, 1917, xxxvi, 576) described the application of the test to routine analysis, and Lawson and Scott (*J. Biol. Chem.*, 1925, lxiv, 23-28), used an electrolytic method for the generation of the necessary hydrogen. The principle adopted by most of these investigators was the same; hydrogen being generated in the presence of the material under examination, and the evolved gas allowed to pass along the surface of a narrow strip of paper impregnated with mercuric chloride or mercuric bromide, when, if arsenic was present, the arsenic hydride liberated produced an orange-brown stain varying in intensity throughout its length. This method is still widely adopted in America, but in this country greater precision is obtained by the use of the method first advocated by Goode and Perkin (*loc. cit.*), in which the evolved gases pass through a definite area of mercuric chloride paper, thus yielding a stain of definite size, and of even intensity. Recently King (*Chem. and Ind.*, 1928, xlvii, 304) has shown that the Gutzeit test is the most sensitive and reliable of any yet proposed if ultra-violet light instead of daylight, is used for the examination of the stains.

The authors have had considerable experience in the use of the Gutzeit test during the past four years, and are of the opinion that carried out in the manner to be described, it is simple in operation, demands little attention, and is as accurate as the Marsh-Berzelius estimation without susceptibility to many disturbing factors possessed by the later. For these reasons it would appear to be eminently suitable as a routine test, particularly as a large number of estimations may be started together and then left without further attention.

The apparatus consists of a wide-necked bottle of about 200 cc. capacity, closed by a rubber bung perforated with one hole, in which is held vertically a narrow glass tube joined at its upper end to a wider glass tube about 1 in. in diameter, and 3½ in. long, The tube is loosely packed with a wad of glass wool impregnated with lead acetate to remove hydrogen sulphide and other interfering compounds from the evolved gases, and is closed at the upper end by a rubber stopper perforated by a hole 5 mm. (1-5th in.) in diameter. The top surface of this stopper must be flat and smooth, any lettering or other irregularities being removed by gentle friction on emery cloth. On this surface the mercuric chloride paper is laid during an estimation, and is kept in place by a loose cap made of a disc of glass 5 cm (2 in.) square, ground on the lower surface, to which is cemented a section of cardboard tube of 4 cm. diameter and 2½ cm. long.

To carry out the test, the material under examination is placed in the bottle with 10 grms. of zinc and followed by 25 cc. of 10 per cent. hydrochloric acid diluted with an equal volume of water. The bottle is immediately closed with the rubber bung and a piece of mercuric chloride paper is laid on the upper stopper to cover the hole, after which the cap is super-imposed and pressed down lightly with the finger for a few seconds. The reaction is allowed to proceed for at least 1 hour, after which the mercuric chloride paper is removed, and the stain, if any, is compared with similar stains produced from known amounts of arsenic. The amounts of arsenious oxide used for the production of standard stains should lie within the range of 0.001 and 0.015 mgrm., since any quantities beyond these limits produce stains which are either invisible or too intense to be read with accuracy. These yellow or orange-brown

stains are not permanent, and in spite of various suggestions, met with in the literature from time to time, this problem has not yet been solved. We have found that by keeping the stained papers in the dark, protected from the laboratory atmosphere, the fainter stains (below .008 mgrm. arsenious oxide) retain their intensity for several days, but the heavier ones are usually more fugitive. Some workers advocate intensification of the stains by exposure to ammonia, but in our experience this treatment frequently leads to erratic results, besides greatly increasing the impermanence of the stains. The fugitiveness of the stains is, however, of little importance, since it is a simple matter to set up a few standards with each batch of estimations, and for routine work in which a "limit" test is frequently employed, one standard stain is sufficient. Such contemporaneous standards also serve the useful purpose of controls on the proper working of the apparatus.

The application of the method to the materials most frequently examined in a brewing laboratory is given in detail below.

MALTS.

It is in general inadvisable to test a substance for arsenic without first destroying the organic matter, since in many cases a fraction only of the arsenic is indicated by the final stain. In this respect the Gutzeit method has considerable advantages over that of the Marsh method, since it is unaffected by many volatile organic substances, traces of which render the latter method useless. Although the most accurate results can be obtained by igniting the malt to destroy organic matter, it is usual in many laboratories in order to economise time to determine the arsenic on malt without previous treatment, and since the organic matter present in this material is more or less constant in composition, a definite correction for the result obtained should be determinable. An extensive series of tests has shown that with pale and amber malts the arsenic indicated by the Gutzeit stain ranges between 71 to 83 per cent. of that actually present. Thus, taking the mean value of 77 per cent., the approximately correct result will be obtained by multiplying the arsenic indicated by a factor of 1.3.

For the actual estimation a convenient amount of malt, from 10 to 25 grms, is placed in the bottle with 10 grms. of zinc, and 25 cc. of 10 per cent. hydrochloric acid diluted with 25 cc. of water are run in, the subsequent procedure being as detailed above.

HOPS, GRAINS, SUGARS, ETC.

Owing to the loose texture of hops and the retarding effect of their constituents upon the evolution of arsenic it is impossible to obtain reliable results without reducing the material to ash. For this estimation 12 grms. of well-mixed hops or other material are placed in a porcelain basin together with about 150 cc. of water and 5 cc. of a 20 per cent. solution of magnesium nitrate, the whole being gently boiled and evaporated to dryness, after which the residue is carefully ignited until free from carbon. The ash after cooling is treated with 20 cc. of 10 per cent. hydrochloric acid and 1 drop of 20 per cent. stannous chloride solution, and heated on a boiling water-bath for 5 minutes. When cool the solution is diluted to 60 cc., mixed and filtered. Aliquot portion of the filtrate are transferred to the Gutzeit apparatus, together with the necessary zinc and acid.

LIQUIDS CONTAINING ORGANIC MATTER.

To 120 cc. of the liquid contained in a porcelain dish is added 5 cc. of magnesium nitrate solution, the mixture being evaporated to dryness and subsequently ignited until free from carbon. The ash is then treated by the method described above for hop ashes.

REAGENTS, ETC.—ZINC.

This may be used in the form of rod, turnings, or the granulated metal, but should in all cases be free from arsenic and antimony, and also iron compounds insoluble in acid. It is advisable when purchasing to obtain samples from different dealers, and to submit them to the following tests: (*a*) a blank estimation using 10 grms. of zinc, 50 cc. of 10 per cent. arsenic free hydrochloric acid and 50 cc. of water. This should be run for 2 hours. (*b*) 10 grms. of zinc, 25 cc. of acid, 25 cc. of water, and 1 cc. of a standard solution containing 0.001 mgrm. of arsenious oxide. (*c*) A similar estimation to (*b*), but using 10 cc. of standard arsenious oxide solution (0.01 mgrm.). With (*a*) no trace of stain should be visible on the mercuric chloride paper; (*b*) should yield a faint yellow stain visible in bright daylight; whilst (*c*) should give a clearly defined orange-brown stain without any trace of greyness.

The suggestion has been made that so-called "insensitive" zinc may be activated by treatment with a solution of a cadmium salt, but there is no difficulty at the present time in obtaining metal which does not require this treatment. When samples of zinc obtained from different sources are dissolved in acid there is considerable varia-

tion in the rate of evolution of hydrogen, but we have not found this factor influences results obtained by the Gutzeit test. It may be noted that the price charged for zinc is no indication whatever of its suitability for the estimation of arsenic by the Marsh-Berzelius or Gutzeit methods.

HYDROCHLORIC ACID.

At the present time it is unnecessary to obtain this acid specially freed from arsenic for the ordinary pure acid of sp. gr. about 1.15 may in most cases be readily purified for use. The acid is diluted to a sp. gr. of 1,050, and to each litre 1 grm. of arsenic free zinc is added and allowed to dissolve completely, after which 4 c.c. of 20 per cent. stannous chloride are added, and the whole thoroughly mixed. The acid is then approximately of 10 per cent. concentration, and if found satisfactory by a blank Gutzeit test is ready for use.

STANDARD ARSENIC SOLUTION.

Pure sublimed arsenious oxide (0.1 grm.) is dissolved in a few cc. of 10 per cent. sodium hydroxide, and the solution is diluted to 1 litre. This strong solution will keep without deterioration for several months. For use 1 cc. of this solution is diluted to 100 cc. and after mixing 1 cc. of this weak solution contains 0.001 mgrm. of arsenious oxide. Since this dilute solution rapidly deteriorates it is advisable to prepare it daily.

MERCURIC CHLORIDE PAPERS.

Good quality opaque filter paper is cut into circular discs about 15 mm. in diameter by boring gently through a wad of papers with a large clean cork-borer. The discs are dropped one by one into a filtered 10 per cent. mercuric chloride solution in alcohol, and are then removed and dried in glass or porcelain dishes in a slightly warm oven free from fumes and hydrogen sulphide. When dry, faulty or stained discs should be rejected and the remainder kept in darkness in a glass-stoppered bottle.

LEAD ACETATE GLASS WOOL.

Many chemists employ either cotton-wool or paper for supporting the lead-acetate used for removal of hydrogen sulphide from the gases evolved in the Gutzeit apparatus, but we have found that any cellulosic material is soon affected by the small amounts of acid present and requires frequent renewal (*Analyst*, 1926, LI, 457). To overcome this difficulty we have substituted glass wool for filter paper, and find that the purifying material remains in good condition without affecting the stains produced for several months. Glass wool is well washed in hot water, and dried at 212° F. It is then immersed in a 10 per cent. aqueous solution of lead acetate slightly acidified with acetic acid, lightly shaken to remove excess of liquid and dried at a temperature not exceeding 100° F. After each estimation the purifying tube containing the lead acetate wool should be kept in a warm place at about 80° F. for several hours to eliminate any condensed moisture.

MAGNESIUM NITRATE SOLUTION.

Fiftyfour grms. of arsenic-free magnesium oxide are dissolved in a slight excess of dilute nitric acid, the solution filtered several times through the same filter paper to remove traces of insoluble ferric oxide usually present and made up with water to 1 litre.

In regard to the presence of arsenic in malt and hops, and its occurrence in the finished beer, a relatively large proportion of this element present is eliminated during the brewing process partly by deposition on the copper plant, and partly by absorption by the yeast. Thus a beer of 1045° gravity having a hop-rate of $1\frac{1}{2}$ lb. per barrel brewed from malt containing 1.300th grain and hops, 1-40th per lb. of arsenious oxide should, if the whole of the arsenic were transferred, contain 1-150th grain per gallon. Actually the amount present in the finished beer varies roughly from nil to 1-500th grain per gallon, a value well below the limit laid down in the findings of the Royal Commission (1902).

(* *From the Journal of the Institute of Brewing, October*, 1928.)

ANALYSIS OF BAUXITE AND OF REFRACTORIES OF HIGH ALUMINA CONTENT.

By G. E. F. LUNDELL AND J. I. HOFFMAN.
(U.S. Bureau of Standards.)

A study has been made of the analytical details involved in the analysis of bauxite and burnt refractories of high alumina content. The work has shown that an accurate analysis of these materials is a far more difficult problem than it is ordinarily thought to be. In spite of the fact that the determination of alumina is usually regarded as very simple, extreme values of 54.84 and 56.68 per cent. were reported by the analysts who co-operated on the analysis of the Bureau of Standards standard sample of bauxite No. 69 (actual Al_2O_3, 55.06 per cent.). The results for alumina and silica reported in the analysis of the standard burnt refractores Nos. 76, 77, and 78 were even less satsfactory. The improper drying

of bauxite and the difficulty of putting burnt refractories into complete solution were found to be sources of error.

Other sources of error, such as improper ignition of precipitates of aluminium hydroxide, misleading corrections for impurities derived from reagents, etc., are pointed out. An umpire method is given for the determination of SiO_2, Al_2O_3, P_2O_5, Cr_2O_3,V_2O_5, Fe_2O_3, TiO_2, ZrO_2, CaO, and MgO. In addition, a routine method for Al_2O_3 is described. In this method the solution of the sample is divided into three aliquots. In the first aliquot the Al_2O_3, Fe_2O_3, TiO_2, ZrO_2, P_2O_5, and V_2O_5 are precipitated by NH_4OH. In the second aliquot the Fe_2O_3, TiO_2, ZrO_2, and V_2O_5 are precipitated by cupferron. In the third aliquot the P_2O_5 is determined. The Al_2O_3 is then found by difference.

GENERAL NOTES.

OVERSEAS TRADE.

His Majesty's Consul-General at Lourenco Marques (Mr. Joseph Pyke) reports that tenders are invited by the Treasury of the local Government (Almoxarifado de Fezenda de Lourenco Marques) for the supply of various materials required for the Posts and Telegraphs Department at Lourenco Marques. The list of goods to be supplied includes the following items :—

Galvanised iron, copper and bronze wire; iron posts; insulators; galvanometers; polarised relays; buzzers; switchboards; wall and table telephones and accessories; pocket voltmeters; batteries; sulphuric acid; lanterns; caustic soda, etc., etc.

Tenders will be received up to 10 a.m. on the 24 November, by the :—

Comissao Permanente de Compras,
Curadoria do Patrimonio,
Lourenco Marques.

A preliminary deposit of 13,000 escudos is required in order to qualify any tender.

A copy of the conditions of tender with particulars of the materials required (in Portuguese) may be consulted by British firms interested at the offices of the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., up to 3 November, after which date it will be available for loan in order of application to firms in the Provinces who are unable to arrange for inspection in London.

Should a translation of the above-mentioned document be required, the Department should be notified at once. The maximum cost will be £2, which will be reduced proportionately in the event of more than one firm requiring a copy.

Local representation essential.

NEW FUEL RESEARCH LABORATORIES AT DEPARTMENT OF MINES, OTTAWA.

The Dominion Department of Mines at Ottawa, Canada, is pre-eminently a Department of scientific research, its varied activities embracing investigations in the fields of geology, mineralogy, petrography, borings, fuels and fuel testing, ore dressing and metallurgy, and ceramics and road materials. These investigations are carried on continuously in the laboratories of the Department at Ottawa and in the field, and no problem is too intricate or too small to receive attention if it is in any way related to the development of mining and its allied industries in the Dominion.

The latest development in the research programme of the Department is featured in the construction of a new Fuel Research building, in which facilities will be available for larger and more varied investigations on fuels than have hitherto been possible in Canada. The front portion of the building (sixty-three feet by fifty-six feet), consisting of a basement and two floors, will contain the chemical laboratories and will provide ample office space for the technical staff, while the rear portion, having a floor space of eighty-feet by fifty-six feet, with a maximum head room of fifty feet, will be devoted to technical and semi-commercial scale processing installations.

More than $150,000 is being expended on the erection and installation of this unit, which, when completed, will be the best equipped fuel research laboratory in America. The work now being conducted by the Division of Fuels and Fuel Testing, which includes investigations into the more efficient economic utilisation of the solid, liquid and gaseous fuels produced in Canada, will be transferred to the new laboratories in the winter of 1928-29. Facilities will be available for chemical and physical analyses and for both small and large scale research investigations. In addition to the usual apparatus for testing and analytical work, the equiment of the new laboratories includes a by-product recovery coking plant, powdered fuel steam generating equipment, and briquetting and coal washing plants, all of which are designed for test work on a commercial scale. Modern equipment is

also being provided for research work in low temperature carbonisation, the liquefaction of coal and the production of synthetic motor spirits, the distillation of oil shales, and for experiments in house heating with different Canadian fuels.

The results of the Department's investigations in fuel testing and in other lines of research are embodied in Annual Reports and in other publicatios issued from time to time, copies of which will be mailed to those interested, on request to the Mines Branch of the Dominion Department of Mines at Ottawa. They can also usually be obtained from the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

TALLOW WANTED FOR SOUTH AFRICA.

His Majesty's Senior Trade Commissioner in South Africa reports that the South African Railways and Harbours Administration are calling for tenders (Tender No. 1341) to be presented in Johannesburg by the 15 November, for the supply of tallow.

Firms desirous of offering tallow of British manufacture can obtain further particulars of this call for tenders upon application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference number B.X. 4825 should be quoted.

AIR PREHEATER CONTRACTS.

The increase in the use of pulverised fuel firing, especially in Power Stations, is bringing the Air Preheater into greater prominence, and we are informed by Messrs. Howden Ljungstrom Preheaters (Land) Ltd., that they have recently secured the third repeat order from the Shanghai Municipal Council for Air Preheaters for the Riverside Power Station in that city.

The contract calls for four preheaters of the well-known rotary regenerative type which is exclusively constructed by this company. Each preheater is to be installed on a 100,000 lbs. boiler, and brings the total of preheaters of this type up to 11 in the Shanghai Power Station.

The Company have further established their reputation for high efficiency preheaters specially suitable for pulverised fuel boilers by securing a contract for the supply of a preheater to the Neasden Station of the Metropolitan Railway Company.

Obituary.

PROFESSOR E. J. WALL.

The recent death of Prof. E. J. Wall, the well-known photographic chemist and scientific editor of *American Photography* removes one of the old school of investigators of the chemical processes of photography.

Prof. Wall was fascinated by early experiments with test tubes and selected chemistry as the particular field for his life endeavour. During his student days he took a few lessons from a photographer in the wet collodion process, which he used for making photomicrographs and soon began to make collodion dry plates and emulsion of his own. After a few years as a practical chemist he joined the staff of B. J. Edwards & Co., of London, who were the first to introduce orthochromatic plates. Here he acquired a knowledge of gelatine emulsion making as well as the coating and sensitising of albumenised paper, which was then the principal commercial printing process. In 1889 he wrote the " Dictionary of Photography, and was later one of the authors of Cassell's " Cyclopædia of hotography." From 1889 to 1892 he edited *Photographic Answers*, a monthly journal devoted to the technical side of photography. In the latter year he became editor of *The Amateur Photographer* and translated for serial publication in that journal Volume III of Eder's " Handbuch," dealing with gelatine emulsion making. He also translated Fritz's " Photolithography," and wrote a manual of the carbon process. In 1896 he became editor of *The Photographic News* and instructor in three colour work in the London County Council School of Photo-engraving. In 1900 he became chemist to the European Blair Camera Co., which specialised in the manufacture of celluloid as well as cinematographic and roll film. While connected with this firm he had a serious accident which kept him on his back for two years. Happily, he was able to keep up his writing and published a translation of König's " Natural Colour Photography." He was for many years a member of the staff of *The British Journal of Photography* until he went to America in 1910 to make celluloid acetate and motion picture film for the Fireproof Film Co., of Rochester. In 1912 he was appointed Professor of Photography at Syracuse University. Since 1921 he has devoted his time to writing and consulting work on photographic patents and technical problems. From his first coming to America

he wrote photographic abstracts for *American Photography*. In recent years he has published "Practical Colour Photography," "Photographic Facts and Formulas," and "The History of Three Colour Photography," the latter being pronounced by competent judges to be the most thoroughgoing and exhaustive treatment of any photographic subject ever produced in any language. This magnificent volume of 757 pages refers to some 9,000 original articles and 8,400 patents. He has been a member of the Royal Photographic Society since 1892, a Fellow since 1895, and served for several years as a member of the Council and judge of the technical section of the annual exhibition. He was a Fellow of the Chemical Society, a member of the Society of Chemical Industry and the Society of Motion Picture Engineers.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

At the meeting held on Thursday, November 1, the following papers were read :—

Gaseous Combustion at High Pressures. Part XI.—Further Experiments on the Influence of Hydrogen and Steam on the Explosion of Carbonic Oxide-Air, etc. Mixtures. By W. A. Bone, F.R.S., D. T. A. Townend, and G. A. Scott.

(1) It has been found that the peculiar influence of CO by H_2 replacements observed by Bone and Haward (Part II hereof, *Proc. A*, vol. 100 (1921) p. 67), in the explosion of $2(mH_2+nCO)+O_2+4N_2$ mixtures at initial pressures of 50 atmospheres and room temperature comes in abruptly when the H_2 content of the mixture exceeds about 0.65 per cent. and is of the nature of a "knock" effect, which may be eliminated by raising the bomb temperature to 100° C. without altering the charge-density.

(2) When such "knock" effect has been eliminated by the means referred to, effects of CO by H_2 replacements upon explosions of the mixtures in question are twofold, namely, initially and up to a certain point, which is reached when about 1.0 per cent. of hydrogen is present, definitely "catalytic," but afterwards purely "additive" only, the second phase being attributable merely to a speeding up of the flame propagation resulting from the concurrent combustions of a relatively fast-burning theoretical H_2-air and a relatively slow-burning theoretical CO-air mixture.

(3) Successive small additions of steam to a theoretical CO-air mixture on explosion at initial pressures of 32.2 and 64.4 atmospheres respectively, and at an initial temperature of 100° C. accelerate combustion (but without the steam intervening chemically in the sense of being continuously decomposed and regenerated), "optimum" conditions being nearly reached in each case when but 1 per cent. only of steam is present.

(4) The addition of a small quantity of hydrogen has a greater effect than its equivalent of steam in speeding up the explosion of a CO-air mixture at high pressures.

(5) Apart altogether from any influence which mere "dryness" may have during the explosion of a theoretical CO-air mixture at high initial pressures, the progressively increasing "lag" in t_m, previously observed as the initial pressure rises, is principally a nitrogen effect, because (*a*) it is not observed at all when the nitrogen is replaced by its volume equivalent of either carbonic oxide or argon, and (*b*) it persists irrespective of the hygroscopic condition of the medium.

Gaseous Combustion at High Pressures Part XII. The Influence of Steam and Temperature, respectively, upon the "Explosion Limits" of Carbonic Oxide-Air Mixtures. By W. A. Bone, D.Sc., F.R.S., D. M. Newitt and C. M. Smith.

The explosion limits of CO-air mixtures have been determined at an initial temperature of 100° C. and at initial pressures of 32.2 and 64.4 atmospheres, respectively, both for "dry" mixtures and for mixtures in an 80 per cent. saturated condition.

In the case of "dry" mixtures the effect of increase of initial pressure is denfiitely to narrow the explosion range; thus the range found for an initial pressure of 32.2 is narrowed by 9.4 per cent. on doubling the pressure. This result confirms previous observations made with "dry" mixtures at an initial temperature of 18° C.

The influence of increasing initial pressure on "moist" mixtures is to shift each limit slightly downwards without, however, altering the "explosion range."

The Theory of Metallic Corrosion in the Light of Quantitative Measurements. II. By G. D. Bengough, J. M. Stuart and A. R. Lee. Communicated by H. C. H. Carpenter, F.R.S.

Forms of corrosion-time curves for zinc in potassium chloride solutions in presence of oxygen have been defined at 25° C. and 760 mm. over the range N/20000 to N.

Each curve has a short initial branch, concave upwards. This soon changes over into a second, which may take one of several forms according to conditions of experiment. With solutions as weak as N/1000, displaced hydrogen may either appear as gas or be oxidised. In N/10 nearly 15 per cent. of the total corrosion is associated with gas evolution. The curve for this part of the corrosion is approximately parabolic and is controlled by the presence of films of metal of low over-potential for a considerable initial period.

The curves for corrosion due to oxygen absorption are exponential in weak solutions (up to about N/50000) and straight lines steeply inclined to the horizontal in stronger solutions (up to N at least). The controlling factors are concentrations of chlorine ions for exponential curves and rate of oxygen supply for straight lines. Slopes of straight lines depend upon rate of oxygen supply and concentration of solution. The final branches of curves for strong solutions are approximately straight lines of low inclination to horizontal, probably controlled by accumulations of secondary corrosion products. The final amount of corrosion is independent of oxygen supply and is determined by concentration of chlorine ions, and rate of their withdrawal from solution. Results so far obtained are in general agreement with the theory of corrosion outlined in Part I of this research.

A Further X-Ray Investigation of Long-Chain Compounds. By A. MÜLLER. Communicated by Sir William Bragg, F.R.S.

The X-ray investigation of long chain compounds (*Roy. Soc. Proc.* vol. 115, p. 542, 1927) has been continued. The fortunate discovery of a single crystal of a normal hydro-carbon n—$C_{29}H_{60}$ has made it possible to determine with considerable accuracy certain details of the structure of a long chain molecule.

The ratio of the length of the fundamental sub-period of the chain has been measured to 1 part in 1,000. Various other constants have been less accurately determined.

Each carbon atom in the chain is known to be associated with two hydrogen atoms, with the exception of each of the end atoms to which three are attached, forming methyl groups. If each carbon atom with its two hydrogens be considered as a separate group capable of representation by a single scattering centre, the chain is found to have a regular zig-zag form with a centre at every corner. The two end carbons may with very good approximation be taken to be represented by the two ends of the zig-zag. The centres therefore lie on two parallel lines, 15 on one, 14 on the other. The ratio of the distance between two consecutive centres on the same line to the length of the chain, the sub-period of the chain, is .03286 ±.00002. As the length of the chain is 77.2 AU, this distance is 2.53_7 AU, which is, within the limits of experimental error, the distance between two corresponding atoms in diamond. The closest distance between two lines of centres belonging to different molecules is 3.7 AU. Thus there is room for the replacement of hydrogens by oxygens, and in fact it is found that the dimensions (though not the intensities of the reflections) of the ketone $C_{30}H_{60}O$ and the hydrocarbon $C_{30}H_{62}$ are identical.

The area of cross section of the molecule is found to be 18.5×10^{-16} sq. cms., a result in good agreement with the values already determined in the case of other single crystals of long chain compounds.

The following papers were read in title only :—

The Production of New Radiations by Light Scattering.—Part I. By C. V. RAMAN, F.R.S., AND K. S. KRISHMAN.

In two preliminary papers the authors have shown that when any transparent medium is irradiated by monochromatic light the radiations scattered by the molecules contain several spectral lines of modified frequencies, the difference between incident and scattered frequencies corresponding to a characteristic infra-red frequency of the molecule. The present paper describes further studies on these radiations.

(*a*) Using the λ 4358 group of lines of the mercury arc as the exciting radiations, the scattered spectra of benzene, toluene and carbon tetrachloride have been photographed and measured.

(*b*) The characteristic infra-red frequencies of the molecules are calculated from the frequencies of the modified lines and compared with values obtained from direct measurements of infra-red absorption. Several molecular frequencies hitherto unknown are obtained.

(*c*) The usefulness of light-scattering as a powerful, convenient and accurate method of exploring molecular spectra, is pointed out.

(*d*) Most of the modified lines are of smaller frequency than the exciting line. There are some relatively feeble lines whose frequencies exceed the exciting line by an these lines we have for the first direct experimental proof of *induced emission* (a-

negative absorption) of radiation by molecules.

(*e*) The scattered lines are sometimes accompanied by a nebulosity or continuous spectrum, extending unsymmetrically on the two sides. Its origin is discussed.

(*f*) The modified radiations scattered at 90° exhibit striking polarisation, the degree of polarisation being different for lines corresponding to different frequency shifts. A tentative explanation is suggested.

(*g*) Some preliminary remarks are made regarding dependence of intensities of modified lines on wave-length of exciting line.

Tribo-Electricity and Friction.—IV. By P. E. SHAW. Communicated by Sir William Hardy, F.R.S.

(1) Tribo-electric charges arise by the clash of solid surfaces as when fine particles are blown at high speed through a tube or nto a large vessel. The material composing the particles or the inside wall of the vessel is selected so that like or unlike materials may clash.

The charges on the particles, the vessel, and the air are separately measured.

(2) Special interest attaches to the action of sand on sand or of ice on ice, on account of the electric sand storm and electric snow storms found in certain regions of the earth. These cases are investigated.

(3 The principal experiments, however, are made on metal particles and metal surfaces.

When the particles and surfaces are *unlike* (*e.g.*, Zn filings and Cu surface), the amount of charge is closely proportioned to the well-known electrochemical values.

When the particles and surface are *alike* (*e.g.*, Zn filings and Zn surface), no charges would be expected according to accepted theory; but such charges on filings, surface, and air invariably arise.

(4) The writer has shown in previous papers that like insulators in clashing generate charges. So the general law now emerges that charges arise by the clash of solids, like or unlike, metallic or nonmetallic.

The Form of the Central Carbon Atom in Pentaerythritol Tetra-acetate as shown by X-Ray Crystal Analysis. By I. E. KNAGGS. Communicated by Sir William Bragg, F.R.S.

The X-ray examination of crystals of Pentaerythritol Tetra-acetate was undertaken with a view to studying the behaviour of the central carbon atom in a compound in which the four carbon valencies are satisfied by like groups.

Pentaerythritol Tetra-acetate is found to crystallise in the tetragonal bipyramidal class; the crystals are built on the Bravais *lattice*, Γ_t and the *space group* C_{4h}^4; there are two molecules in the unit cell, which has the dimensions $11.98^2 \times 5.47$ A.U.

The molecule possesses a four-fold alternating axis of symmetry, which must pass through the central carbonation. The central carbon atom itself may be tetrahedral, though some slight departure from true tetrahedral symmetry is possible.

A probable structure for the crystals is suggested.

The Band Spectra of the Alkaline Earth Halides. I CaF_2, SrF_2. *II* BaF_2, MgF_2. By R. C. JOHNSON. Communicated by T. R. Merton, F.R.S.

The first paper represents a continuation and extension of theoretical work done recently on these band spectra by Meckel. A complete quantum analysis of the gross structure of the whole of the bands has been made, and for this purpose a remeasurement of some 250 of the heads under high dispersion was undertaken. The molecules CaF and SrF give rise to at least three band systems which are analogous in almost every respect. These are assigned to the electron transitions $3^2S \rightarrow 1^2S$, $2^2S \rightarrow 1^2S$, $2^2P \rightarrow 1^2S$. The vibrational constants of the molecules in these various states have been evaluated. Many unusual features found in these band spectra, such as the fewness of the sequences and their exceptional length, are attributed to the smallness of the variation of these vibrational constants with electronic state. Among the unusual features also observed and discussed are (*a*) the occurrence of strong Q branches in $^2S \rightarrow {}^2S$ transitions, and (*b*) a definite discrepancy in $f(n'')$ as evaluated from the $^2S \rightarrow {}^2S$ and $^2P \rightarrow {}^2S$ systems.

In the second paper a quantum analysis is made of the gross structure (of the band spectra) of the BaF_2 and MgF_2 molecules. In the case of the barium fluoride bands, new measurements of the heads have been made, from plates taken in the first order of a 21-ft. grating. The familiar BaF bands in the green region are believed to constitute two systems attributed to the electron transitions $2\ {}^2S \rightarrow 1^2S$, and $3\ {}^2D \rightarrow 1^2S$. A number of bands measured by George and attributed by him to BaO have been analysed and found to have their final state in common with the BaF systems, thus proving their fluoride origin. This system is believed to be due to $2\ {}^2D \rightarrow 1^2S$. These suggested transitions of the type $^2D \rightarrow {}^2S$, which are believed to be new to band

spectra, are discussed. The absence of the transition 2 $^2P \rightarrow 1^2S$ from the recorded data of the BaF molecule is noteworthy. The recorded emission bands of MgF_2 constitute a 2 $^2P \rightarrow 1^2S$ system, in which $\Delta 2\ ^2P =$ 18.6v. The vibrational constants of these various states of both the BaF and MgF molecules are given.

The Band Spectra Associated with Zinc, Cadmium and Mercury. By J. M. WALTER AND S. BARRATT. Communicated by T. R. Merton, F.R.S.

(1) The majority of the supposed band absorption spectra of zinc and cadmium, and one band system previously attributed to mercury, would appear to be oxide and chloride spectra.

(2) In the present experiments, the only bands found which can be attributed to zinc and cadmium themselves, are two weak and diffuse bands, one for each metal. The absorption spectrum of mercury, however, is much richer, and there is no doubt that mercury vapour contains diatomic molecules.

(3) The bromides of the three metals, together with the iodide of cadmium, all yield absorption band systems analogous to the chloride bands.

Observations in Connection with the Band Systems of the Fluorides of Beryllium and Magnesium. By W. JEVONS. Communicated by H. C. Plummer, F.R.S.

The vibrational analyses of the band-head data for the BeF_2 and MgF_2 doublet systems lead to the following interpretations of the heads in each band, those in brackets not having yet been detected. In BeF_2 :R_2, R_1, Q_2 (Q_1) with a doublet separation of the order $R_2 - R_1 = 3$ cm.$^{-1}$, rather than R_2, Q_2 (R_1), Q_1 with a separation $Q_2 - Q_1 =$ 35 cm.$^{-1}$ as hitherto assumed. In MgF_2 : P_1, Q_1, (P_2), Q_2 with an electronic doublet separation $Q_2 - Q_1 = 5.5$ cm.$^{-1}$, not 22 cm.$^{-1}$ as hitherto given. With these interpretations there is now a continuous increase of the separation of the system-origins of the doublet systems of the alkaline earth fluorides from BeF_2 to BaF^2.

With BeO in the carbon arc in air conditions may be so arranged as to obtain in the outer flame either (*a*) the BeF_2 system strong with the BeO system relatively weak, or (*b*) the BeO system strong with hardly a trace of the BeF system. In condition (*b*) the ultra-violet region λ3500 - λ2900 (where the BeF_2 system would occur if developed) is occupied by a new set of bands, which, like the BeF_2 and BeO bands, are degraded towards the red. A similar result is obtained, though less satisfactorily, with other Be salts instead of BeO. The new bands are less regularly distributed than any bands of diatomic molecules, and are due either to BeF_2 or to an oxide of beryllium. No bands due to $BeCl_2$ and no further bands of BeF_2 have been found.

The data for the BeO band-system are extended by the recognition of a violet sequence $n'' - n' = -$, not hitherto observed on account of the λ4216 sequence of CN and strong metallic lines.

THE CHEMICAL SOCIETY.

Papers read on November 1 :—

Surface Oxidation of Aluminium, Tungsten and Molybdenum. By L. C. BANNISTER.

A study has been made of the surface films of aluminium, tungsten and molybdenum which are formed by oxidation in air, in solutions of oxidising agents, and by anodic oxidation in various electrolytes. A special technique has been developed in order to show films of gradually varying thickness on one piece of metal. These films have been obtained by chemical and electrochemical methods, and their optical properties have clearly shown that the colours exhibited are caused mainly by the interference of light, but are modified by the specific colour of the film. Tables have been compiled showing the variation of the colour with the applied voltage, with the number of coulombs used for formation, and with the time of oxidation. Films from treated aluminium have been further studied by isolating them in hot gaseous hydrogen chloride. They consist mainly of oxide with 4 per cent. of water and a trace of occluded anion from the electrolyte. The oxides produced on molbdenum and tungsten by heating the metals in air are very similar to those produced by anodic treatment in normal solutions of chlorides.

Synthetical Experiments in the isoflavone Group. Part III. A Synthesis of Genistein. By W. BAKER AND R. ROBINSON.

It has been found possible to prepare 5 : 7 : *4′-trimethoxy-2-styrylisoflavone* (I) by methylation of 5 : 7-dihydroxy-4′-methoxy-2-styrylisoflavone with methyl sulphate and sodium hydroxide, first in aqueous methyl alcoholic and then in aqueous acetone solution. Other methods are not applicable either because nuclear alkylation occurs or on account of the failure to introduce the second methyl group. (I) was oxidised in pyridine solu-

tion by means of potassium permanganate with formation of a carboxylic acid, which in its turn furnishes an O-trimethylgenistein on thermal decomposition. The demethylation of the trimethyl ether gave genistein identical with the natural product from *Genista tinctoria*, Linn.

Anthoranthins. Part X. A Synthesis of Gossypetin and of Quercetagetin. By W. Baker, R. Nodzu, and R. Robinson.

The Electrical Conductivities of Some Uni-univalent Salts in Benzonitrile. Evidence for the Incomplete Dissociation of Strong Electroiytes and the Applicability of the Law of Mass Action to their Dissociation. By A. R. Martin.

The conductivities of the iodides of lithium, sodium, and potassium, of lithium bromide, and of silver nitrate in benzonitrile have been measured over a range of dilution from N/500 to N/10,000 or N/50,000, and over a range of temperature from 0° to 70°. The viscosity of benzonitrile over the same range of temperature has been measured. Extrapolation to Λ_0 has been carried out by the square root law and by Ferguson's method. The merits of this latter whole range of temperature Λ_0 is directly proportional to the fluidity of the solvent. The values of Λ_0 for a given salt have been compared with the values in aqueous, methyl alcoholic, and nitromethane solution. The slopes of the Λ, $\sqrt{c}$ straight lines are approximately twice as great as those calculated from the Debye-Hückel-Onsager theory. The whole of the conductivity concentration curve can be described by a dissociation governed by the law of mass action, the mobility of the resulting ions varying with their concentration owing to the Coulomb forces between them, in the manner predicted by the Debye-Hückel-Onsager theory. In extremely dilute solutions dissociation is complete.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Kenkyo Inaba : Alcosol of Silicic Acid.

Kiyohisa Yoshimura and Magoasuburo Tsujimoto : Chemical Study of the Seed Protein of *Cycas revoluta, Thunb.*

Yoshio Sakamoto and Shinroku Mitsukuri : Reaction between Ethylene and Chlorine. I.

Atsushi Watanabe : Oxydase-like Action of Complex Salts of Metals. Part 7. Oxidation of Potassium Iodide by Complex Salts of Cobalt.

THE FARADAY SOCIETY.

Investigations on the Electro-Deposition of Silver, with Special Reference to the Use of Sodium Cyanide. By Edward B. Sanigar, D.Nat.Sc., M.Sc.

The two main objects underlying the work were to study (*a*) the effect of the different bath constituents on the deposit, and (*b*) the behaviour of silver plating solutions made up from sodium cyanide in place of the usual potassium cyanide, to determine whether the salts were interchangeable or not.

As silver is deposited for artistic effect rather than for resistance to corrosion, deposits which can be easily polished are desirable. Since the ease of polishing depends largely on the softness of the deposit it was necessary to obtain a test by which the relative hardnesses of thin deposits of silver could be measured. After preliminary work, during which various standard hardness testers were tried and found to be insufficiently delicate, a scratch hardness test was used for this purpose.

Good silver plating solutions can be made up from sodium salts instead of potassium salts. A suitable vat contains :—

Silver nitrate	3.50 g./litre	
Sodium cyanide	40.4 ,,	= 100 per cent. excess cyanide.
Sodium carbonate	80.0 ,,	

This solution, which has an adequate conductivity (9.08×10^{-2} mhos. at 25° C.), has been tested and gives good, satiny deposits when worked at current densities of 0.302 amp./sq.dm. and upwards.

Increasing carbonate content causes a softening in the silver deposited.

Increasing free cyanide content up to 200 per cent. excess makes a silver deposit softer, after which value the type of deposit changes and also becomes harder. The amount of free cyanide present largely determines the hardness of the deposit.

Variation of current density has relatively little influence on the hardness of silver deposits, high values favouring soft deposits. Good deposits can be obtained using high current densities provided that suitable solution composition and agitation are used.

With pure salts good silver deposits can be obtained from solutions containing both sodium and potassium cyanides. However, with old solutions particularly, the two cyanides should not be used together indiscriminately, since troubles apparently arise from the use of impure salts.

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College of Science and Technology, South Kensington, at 7.30 p.m., on Thursday, 8 November, 1928. The following papers were read and discussed :—

"On Systems of Plane Reflecting Surfaces." By T. Smith, M.A., F.Inst.P.

"Reflecting Systems for Image Inversion." By T. Smith, M.A., F.Inst.P.

"The Relation Between Field Illumination and the Optimum Visual Field for Observational Instruments." By L. C. Martin, D.I.C., A.R.C.S., B.Sc.

INSTITUTE OF METALS.

London Local Section.

A specially interesting meeting of the London Local Section of the Institute of Metals was held on Thursday, November 8, at 8 p.m., when Professor W. E. Dalby, F.R.S., gave an address at the Royal School of Mines, South Kensington, S.W.7., on "The Plastic Contour." The work of Professor Dalby on the mechanical properties of materials is so well-known that the lecture attracted a large audience. Professor Dalby dealt with the development of the instruments which he has devised for the examination of the mechanical properties of materials. He also described the results of his tests and discussed some of the problems which arise when a metal extends or contracts under stress.

NOTICES OF BOOKS.

Alchemy and the Secret Doctrine. By H. P. Blavatsky. Edited by Alexander Horne. Pp. x + 207. The Theosophical Press, Wheaton, Illinois, U.S.A. 1927.

Mr. Alexander Horne has undertaken the task of "analysing" two of the works of the late Madame H. P. Blavatsky (*The Secret Doctrine*, and *Isis Unveiled*) with the object of presenting an account of the underlying ideas in their bearing on Alchemy, whilst at the same time retaining the language and even the text of the author.

An attempt has thus been made to correlate the latest discoveries of science with early mystical and alchemical doctrines. By the Secret Doctrine is meant the "universally diffused religion of the ancient and prehistoric world." Proofs of its diffusion, authentic records of its history and the teachings of the Adepts exist to this day, we are told, in the crypts of libraries belonging to the Occult Fraternity. One of these is somewhere along the ridge of Altyn-Tagh, whose soil no European has ever trodden. The small cluster of houses is a hamlet rather than a monastery, with a poor temple, and pilgrims say that the subterranean galleries contain a large collection of books, more indeed than are kept at the British Museum. So that for ages the secret of the adepts has been kept.

Enthusiasm for the achievements of the ancients has led Mme. Blavatsky to be at times contemptuous of modern scientific accomplishments and where these conflict with the views of the mystics the suggestion is that the latter are in the right for they possessed skill and knowledge of the arts now lost. The ancients, it is held, penetrated the secrets of nature much deeper that the philosophers of the present day. They fabricated, for instance, the cup of glass which was unbreakable although it could be bent. They knew of the universal solvent, the alkahest. There is also a recital of the accomplishments of Egypt and Chaldea with the inference that the scientists of to-day are less well equipped with knowledge. A thorough appreciation of these views is rather difficult because the exponents of the Secret Doctrines of Alchemy are as sceptical of modern scientific knowledge as the exact scientist is of the utility of retaining theoretical views, often based on inadequate practical knowledge or even on none at all.

Among the remarkable claims of the forerunners of modern science are those of the perpetually burning lamps which remain alight for centuries without attention or renewal of the combustible body. Because this is unacceptable to chemists of to-day it is inferred by Mme. Blavatsky that the alchemists possessed an art which is now lost. In support of this contention it is pointed out that perpetual motion has been regarded in scientific circles as an impossibility whilst the views of the atomists are that perpetual motion is being maintained within the atom as it is on a larger scale in the planetary universe.

Again the claims of oriental Yogis to extreme longevity are credited upon the writings of medieval authorities. The mercurial preparations consumed to ensure this, if rediscovered would, we are told, enable people of this era to attain similar lengths of life.

It is mentioned that Occult Science recognises seven cosmic elements. The so-called superstitions of the ancients, their personification of the forces of nature, did

not arise from ignorance, but from a keen sense of oneness with nature. The cosmic elements are the spiritual intelligences fashioning the Cosmos according to divine plan and a diagram is given to indicate the parallelism between four chemical elements and these seven "cosmic elements" (p. 107), thus—

Human Principles.		*Physical Nature.*
7 Atmâ		
6 Buddhi		
5 Manas	HYDROGEN.	It burns in oxygen, giving off the
4 Kâma Rûpa; the principle of animal desire which burns fiercely during life.		most intense heat of any substance in combustion.
3 Linga Sharira; the inert form on which the body is moulded; the vehicle of life.	NITROGEN.	An inert gas; the vehicle with which oxygen is mixed to adapt the latter for animal respiration.
2 Prâna; Life; the active power *producing all vital phenomena.*	OXYGEN.	The life-giving gas, the active *chemical agent in all organic life.*
1 *The gross matter of the body.*	*CARBON*	*The fuel par excellence;* the basis of all organic substances.

In the selection of chemical statements and opinions it would seem that the author and compiler have not been too critical. Thus, in referring to Sir William Crookes' views on Meta-elements (views which coincide with mystical and alchemical doctrines) it is rather hastily assumed that these views correspond with actual facts. Again much importance is attached to the unconfirmed claims of Prof. Miethe to the synthesis of gold. This it is held supports the contentions of the medieval alchemists who made similar claims. A chart of the Periodic Law is given at the end of the book and is said to be "after Crookes" but no reference is given and the scheme is open to serious objections on chemical grounds. Indeed it shows but remote resemblance to Mendeleјev's Classification probably because it is made to fit in with the "elements discovered first by clairvoyant investigation."

Mention has been made of the incomplete references. There are 25 altogether but where they fit in with the text is not indicated and nearly all the scientific ones are to popular presentations in American magazines. The reader is left with the impression that the scientific information has been gathered from sketchy articles rather than from original sources. Nevertheless, it must be confessed that the statements and views expressed in this work require serious consideration as many of the ideas may throw useful light on a number of important points. Scientific and general readers should be grateful to Mr. Horne for the trouble he has taken to make clear the views of an ardent champion of the medieval and mystical alchemists.

J. G. F. DRUCE.

MATTER AND LOGIC.

The contributions which have appeared from time to time in *The Chemical News* from Dr. W. Tombrock (Bergen op Zoom, Holland), have been collected by the author in the form of a set of reprints under the above title and form an attempt at a logical explanation of material properties and natural phenomena. The sections are entitled, Atomic Electricity Explained and Explained Away (*Chem. News*, March 30, 1928); The Atom and Some General Material Properties and Phenomena (May 11); The Concept of Mass and the Laws of the Conservation of Matter and of Energy (June 1); The Thoughts of the Ancient Greek Philosophers concerning the Nature of Light and a Glance at the Present Day Light Problems (July 6); Further Speculations Concerning the Nature of Light and Ether (July 6); Is Nature Contradictory? (August 24); Matter, Logic and Some Results of Modern Investigations of the Atom (September 7); and The Crux of the Question (September 28).

Forthcoming Events.

ROYAL SOCIETY OF ARTS.

Monday, November 19, at 8 p.m.—(Cantor Lecture.) Franklin Kidd, M.A., D.Sc., Principal Assistant, Low Temperature Research Station, Cambridge: "Refrigeration." (II.)

Wednesday, November 21, at 8 p.m.—(Ordinary Meeting.) Sir Gerald Bellhouse, C.B.E., H.M. Chief Inspector of Factories, Home Office: "Safety in Factories."

Monday, November 26, at 8 p.m.—(Cantor Lecture.) Franklin Kidd, M.A., D.Sc., Principal Assistant, Low Temperature Research Station, Cambridge: "Refrigeration." (III.)

Tuesday, November 27, at 4.30 p.m.—(Dominions and Colonies Meeting.) Col. H. L. Crosthwait, C.I.E.: "Air Survey and Empire Development." Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., will preside.

Wednesday, November 28, at 8 p.m.—(Ordinary Meeting.) J. H. Estill, O.B.E., Commercial Manager, Port of London Authority: "The Port of London." The Rt. Hon. Thomas Wiles, P.C., will preside.

Monday, December 3, at 4.30 p.m.—(Indian Meeting.) Sir James Mackenna, C.I.E.: "The Sugar Industry of India." Sir Reginald A. Mant, K.C.I.E., C.S.I., will preside.

Wednesday, December 5, at 8 p.m.—(Ordinary Meeting.) Sir Eustace Tennyson d'Eyncourt, K.C.B., D.Sc., LL.D., F.R.S.: "Fuel for Ships." The Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S., will preside.

Wednesday, December 12, at 8 p.m.—(Ordinary Meeting.) G. G. Blake, M.I.E.E., F.Inst.P.: "Applications of Electricity to Medical Practice." Sir Oliver J. Lodge, M.A., LL.D., D.Sc., F.R.S., will preside.

ROYAL INSTITUTION.

Tuesday, November 13, at 5.15 p.m.—"The Change of State from Liquid to Vapour." By Prof. H. L. Callendar, F.R.S.

Thursday, November 15, at 5.15 p.m.—"The Empire and the Native Problem." By Captain G. Pitt-Rivers.

Saturday, November 17, at 3 p.m.—"North Country Folk Music." By Dr. W. G. Whittaker. (With Musical Illustrations.)

INSTITUTE OF CHEMISTRY.

Friday, November 16, at 8 p.m.—Prof. A. R. Ling, M.Sc., F.I.C., will deliver the Eleventh Streatfeild Memorial Lecture in the Lecture Theatre, King's College, Strand, London, W.C.2. Subject: "Contributions to the History of Starch and its Transformation Products." Illustrated by Lantern Slides. Prof. Arthur Smithells, C.M.G., D.Sc., F.R.S., President of the Institute, in the chair.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

One hundred and fifteenth General Meeting at the House of the Royal Society of Arts, John Street, Adelphi, W.C.2.—Tuesday, November 13, at 5.30 p.m.—"Drilling and Production Methods in the Greater Seminole Field, Oklahoma, U.S.A." By George Heseldin, M.Sc., A.M.Inst.C.E., A.M.Inst.P.T.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

30,277.—California Cyanide Co., Inc.—Production of hydrocyanic acid. October 19th.

30,325.—Fuchs, K., and Katscher, E.—Method of producing sulphuric acid and halogen substitutes. October 19th.

29,739.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of sulphonic acids, etc. October 15th.

30,203.—Thorssell, C. T.—Production of nitrates of the alkalies, etc. October 18th.

29,989.—Young, H. J.—Apparatus for chemical purification, etc. of liquids. October 17th.

Specifications Published.

298,587.—Carreras, R. S.—Manufacture of bismuth carbonate and other compounds of bismuth.

274,103.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of naphthalene-1 : 4 : 5 : 8-tetracarboxylic acid.

298,670.—I. G. Farbenindustrie Akt.-Ges. —Recovering of iodine from crude nitrate of soda.

274,488.—Distilleries Des Deux-Sevres.—Process for the manufacture of crotonic aldehyde and its homologues.

280,501.—Suida, Dr. H.—Recovering concentrated acetic acid from dilute acetic acid.

Abstract Published.

296,355.—Hydrocyanic acid; acetylene.—Soc. of Chemical Industry in Basle, Basle, Switzerland, & Andriessens, H., 44, Kaiseralle, Karl-ruhe, Germany.

In treating gaseous mixtures containing methane and nitrogen in a flaming arc to produce hydrocyanic acid and acetylene, the gases leaving the arc are treated to separate the hydrocyanic acid and a part at least of the acetylene before being returned to the arc. The gas circuit described in Specification 195,239 may be used. Hydrocyanic acid may be absorbed in alkali, and acetylene by water under pressure. Hydrogen may be separated from the residual gases before return to the arc by diffusion, partial combustion, etc. In place of methane, petroleum vapour or its constituents may be used.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HAGEDA.

494,763.—Chemical substances prepared for use in medicine and pharmacy.—Hageda, Handelsgesellschaft Deutscher Apotheker Aktien-Gesellschaft, Dortmunderstrasse 12, Berlin, N.W.21, Germany. October 24th.

ART-EMO.

494,450.—All goods in Class 1 which includes acids, potash, salts and other chemical substances used in manufactures.—Arthur Smith, 38, Ashdale Road, Mossley Hill, Liverpool. October 24th.

ATOMLITE.

495,333.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—John Vielle, 35, Cator Road, Sydenham, London, S.E.26. October 24th.

WOLMAX.

492,775.—Chemical substances in Class 1 for use in the preservation of timber, paper, textile fabrics and linoleum. —The British Wood Impregnating Company, Ltd., 30, Norfolk Street, Strand, London, W.C.2. October 24th.

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ORIGIN OF THE HESS-KOLHÖRSTER RADIATION—COSMIC RAYS.

(*Continued from Page* 290.)

Making use of Aston's recent very accurate mass determinations of the atoms and Einstein's equation as given earlier in this article, Millikan and Cameron are able to calculate the energy given out as radiation when 4 hydrogen atoms simultaneously combine to form helium. From this energy they are able to compute the frequency of the radiation and its wave-length. From this frequency or wave-length, they can calculate the absorption coefficient per metre of water by using Dirac's equation (*Proc. Roy. Soc.*, 1926, A111, 423), *i.e.*, his relativity-quantum-mechanics formula.

In showing these steps, first will be given all the constants used; but it should be explained that Aston's packing fractions are the reduced masses of the hydrogen atoms due to close packing in the atoms. For example, the atomic weight of helium is 4.00216. As it is supposed to 'contain' 4 hydrogen atoms, of 1.00778 each when not 'compressed,' 1.00054 *when* 'compressed,' the equation can be written thus:

$$4.00216 = 4 \times 1.00054.$$

By this method the loss in grams per gram-atom is

$$(4 \times 1.00778) - (4 \times 1.00054) = 0.029,$$

which is the value given earlier, namely, the difference between 4H and He—this comes to the same thing.

Aston's packing fractions are plotted and a smooth curve drawn (see *Proc. Roy. Soc.*, 1927, 115, 487). By this means values can be extrapolated; and when this is done for certain radioactive elements, *i.e.*, their atoms, the energy given out by disintegration compares well with the calculated value involving Einstein's mass-energy theory as stated above. Before proceeding further the constants, etc., may be noted for reference.

N = Avogadro's number = 6.062×10^{23}.
h = Planck's constant = 6.547×10^{-27} erg. sec.
c = Velocity of light = 3×10^{10} cms. per sec.
Z = Molecular number for water (H_2O) = 10.
A = Molecular weight of H_2O = 18.
e = Charge on the electron = 4.774×10^{-10}, E.S.U.
m = Electronic mass = 9.05×10^{-28} gram.
h/cm = 0.0242×10^{-8} = 0.0242A, when in cms. (see note).
A = Angström unit = 10^{-8} cm.
α = $(0.0242 \times 10^{-8})/\lambda$ = 53.
μ/ρ = Absorption coefficient for 1 cm. of water.
E = Energy in ergs.
ν = Frequency per second.
λ = Wave-length in cms.

NOTES.—The above values are those used by Millikan and Cameron. But

Continuing the part preceding the table, the energy released is—

$$(0.029 \times 9 \times 10^{20}) / (6.062 \times 10^{23}) = 4.3 \times 10^{-5} \text{ ergs.}$$

The frequency of the æther wave produced is derivable from $E_1 - E_2 = h\nu$; for $\nu = (4.3 \times 10^{-5}) / (6.547 \times 10^{-27}) = 6.57 \times 10^{21}$. This frequency gives a wave-length $\lambda = 0.00046 \times 10^{-8}$ cm.; *i.e.*, $\lambda = c / (6.57 \times 10^{21})$.

Having got all the constants out, the next step is to make the final calculation of the absorption coefficient by using Dirac's equation below, which I have arranged for *machine composition* to save the cost of hand setting. It is not so elegant, perhaps, because the eye is not accustomed to this form (what was elegant to our forefathers in ladies' dress would be hideous to us now). This procedure is exceedingly practical from the printers' point of view, as they can really set up this sort of equation "like winking." I have introduced multiplication signs, as there has to be one at the end of the first line—or at the beginning of the second line—to improve the symmetry of the equation. Working out the equation I get the answer given, which is as it should be.

$$\mu / \rho = (ZN / A) \times (2\pi e^4 / m^2 c^4) \times [(1+a)/a^2] \times \{[2(1+a)/(1+2a)] - [(1/a)\log(1+2a)]\} = 0.0030,$$

when the proper tabulated values above are introduced. Millikan and Cameron say "*These figures yield up $\mu / \rho = 0.0030$, or 0.30 per metre of water, in place of the value 0.35 which we arrived at purely empirically.*"

This procedure was followed out for all the three absorption coefficients which Millikan and Cameron experimentlly arrived at, and they obtained concordant results. It is here noticed that the coefficients multiplied by the atomic number of each respective element gives a constant.

In the case of oxygen, for example, the loss in mass is

$16 \times 0.00778 = 0.1245$ grams per gram-atom.

By Dirac's equation the absorption coefficient $\mu = 0.074$ per metre, which is in close agreement with the values for nitrogen and oxygen in mean.

In these experiments it is always difficult or impossible to eliminate the effect of an adjacent element, so that while oxygen is evidently in greater abundance, nitrogen may at birth emit also a 'cry' but not so strong as that of oxygen, because there is less of it.

It would seem that "we are faced with the irresistible logic of facts"—to quote the words of a popular writer—as everything fits in very well indeed.

Now the question of the process being reversible is one of great interest. This will be discussed again later. Jeans strongly maintains that the universe is running down. See *Nature*, 1928, 122, 689. Millikan and Cameron say otherwise. Nernst (*Journ. Franklin Inst.*, 1928, 206, 135) with Millikan and Cameron argues that the universe is in a steady state.

The coming together at one time in space of a sufficient number of protons and electrons in the right way to form iron or silicon is certainly a difficulty. It might seem from probability considerations an absolutely impossible event. It must be remembered, however, that these 'comings together,' so to speak, involve conditions quite as orderly and complex, as in the formation of a complex organic compound. Nearer and nearer steps first, then a sudden condensation is Millikan and Cameron's idea. I am inclined to believe that some sort of vortex action takes place whereby the protons and electrons are whirled into rings or tubes that gradually bend round or close in and finally *clamp* together, to use Millikan and Cameron's word. Also the whirls observed in sun-spots seem suggestive here and in these cases powerful magnetic fields are produced by the circular motion of electrons. It would be interesting to note whether, when the spots on the sun are large and in favourable position, the cosmic rays are slightly augmented in the sun-spot direction.

In inter-stellar space there are long streamers and whisps of nebulous matter suggesting an æther wind; and in spiral nebulæ, which exist in enormous numbers outside of our galactic system, there are whirls. If these whirls could be imitated in a vacuum tube in some way so as to condense, rather than disperse, matter, then perhaps the formation of helium out of hydrogen would be just discernable by delicate spectroscopic tests, and then if the radiation corresponded with that observed by Millikan and Camerou there would be conclusive proof that the above statements are substantially true.

It must be realised that some of these matters are so obscure and difficult of treatment that one's views must of necessity change as the subject is developed. Science of this kind cannot be written and then signed and sealed and thus settled for all time. It is not an Act of Parliament.

F. H. L.

(*To be concluded.*)

BASIC CARBONATES OF ZINC AND CADMIUM.

By TSUNEKICHI NISHIMURA AND TAKEMARO YAMAMOTO.

(*Tokyo Institute of Physical and Chemical Research.*)

The normal carbonate of zinc ($ZnCO_3.{}^1/_2 H_2O$) prepared at a low temperature in the presence of carbonic acid gas is quite stable and has shown no trace of decomposition after being exposed in the form of a thin layer, for 183 days in the room air. On the other hand, the same salt was slowly hydrolysed in wet state and becomes a basic salt. When air was passed in a rapid current at the room temperature for a long time into suspension of a deposit of the normal carbonate in plenty of water, the salt was decomposed and lost its carbonic acid gradually at first, but the decomposition ntterly ceased after 19 days, and during the following 33 days the deposit maintained the constant composition $ZnO.0,421CO_2.nH_2O$. Again, zinc hydroxide continued slow absorption of carbonic acid from air up to 73 days, after which the absorption ceased and the composition of the deposit remained invariable for the last 134 days, a total of 207 days of our experiment, this constant composition being $ZnO.0,363\ CO_2.mH_2O$. The compounds corresponding to those two compositions must, accordingly, be looked upon as the stable forms in air when in contact with water, *i.e.*, the normal and the reverse reactions arrive at different respective results. Whether the substance $ZnO.0,421\ CO_2.nH_2O$ of the constant composition here obtained be the same as the representative basic salt $5ZnO.2CO_2.3H_2O$ known from old, is not yet evident, but most probably they seem to be different.

The normal carbonate of cadmium, $CdCO_3$ is stable in air, whether in dry or in wet state, and moreover, it suffers no decomposition even when boiled long in water. Cadmium carbonate prepared at a lower temperature, however, is unstable to some extent when fresh, and seems to possibly suffer some temporary decomposition in wet state at least.

In the experiment where a rapid air current was passed through a suspension of normal cadmium carbonate in plenty of water for a long time, a temporary decomposition was clearly seen to take place, and after 15 days the composition reached once at 0.93 mol of CO_2 to 1 mol of CdO, and then the salt began to recover its original composition by absorbing carbonic acid from air, resulting always in the composition of the normal carbonate after 235 days. On the other hand, cadmium hydroxide absorbs plenty of carbonic acid from air rapidly at first under the same conditions as the above, but on arriving at about 0.78 mol of CO_2 to 1 mol of CdO, the absorption suddenly slackens and continues slow and constant absorption til 1208 days after, the quantity of CO_2 arriving at 0.88 mol to 1 mol of CdO. Since any further observation was not possible, it was uncertain whether the result would be different for the normal and reverse reactions in this case as in that of zinc or magnesium carbonate. Further, in these experiments we could not find out any sort of basic cadmium carbonate which will possess a certain definite composition.

METHODS, FORMULÆ, AND TABLES FOR THE CALCULATION OF ANTENNA CAPACITY.

By FREDERICK W. GROVER.

(*U.S. Bureau of Standards.*)

To calculate the capacity of an antenna a certain charge is assumed upon the antenna and the resulting potential is calculated.

In carrying out this method the difficutly is met that, in general, the law of distribution of the charge is not known. Howe made the assumption that sufficient accuracy is attained if first a uniform distribution of charge is supposed to exist and the potential calculated at various points of the antenna, the average of these potentials being taken as the final equilibrium potential. Howe called attention to discrepancies between the values obtained by his method and published values for the same antennas by the inductance method. The present paper shows that the swo methods agree if ippropriate inductance formulas are employed. The Howe method is more general, and it is believed to give sufficient accuracy for engineering requirements.

Formulas are given for the common types of single and multiple wire antennas in a form convenient for numerical computation, together with tables of constants which will be found useful in such calculations. In addition, tables of the capacities of both horizontal and vertical single-wire antennas and horizontal tow-wire antennas have been included, which should render all calculation unnecessary in many important practical cases.

SOME MEASUREMENTS OF THE TRANSMISSION OF ULTRA-VIOLET RADIATION THROUGH VARIOUS FABRICS.

By W. W. Coblentz, R. Stair, and C. W. Schoffstall.
(U.S. Bureau of Standards.)

In this paper measurements are described of the transmission of ultra-violet and visible radiation through fabrics made of various kinds of material—cotton, natural silk, rayon (artificial silk), linen, and wool.

The source of radiation was a quartz mercury arc lamp from which ultra-violet radiation was obtained by filtration through a Corning purple glass 986A, and the visible radiation was isolated by filtration through a yellowish-green glass.

By examining black and white samples of the same material, it was possible to eliminate the effect of the radiation transmitted through the openings between the individual threads and thus determine the amount of radiation transmitted directly through the yarn.

Fabrics of close-weave and open-weave (twill, satin, voile) material were examined. The results obtained on these different weaves are in agreement in showing that, comparing materials having the same weight, there is practically no difference in the amount of ultra-violet transmitted through bleached samples of cotton, linen, viscose rayon, and the rayon made by the cellulose acetate process.

The fresh, white, natural silk is almost as transparent as bleached cotton, while wool is only about half as transparent to ultra-violet solar radiation as bleached cotton.

In all cases when the fabric is dyed, or slightly yellowed with age, the ultra-violet transmission through the thread is greatly decreased. Hence, as is to be expected in comparing various kinds of dyed fabrics, the one having the largest openings between the threads transmits the most ultra-violet.

GENERAL NOTES.

G.P.O. BRONZE WIRE CONTRACT.

Statement by Mr. Thomas Bolton, Chairman of the Non-Ferrous Metal Group of the Federation of British Industries.

On behalf of the manufacturers of bronze wire I desire to direct attention to certain points raised in the letter from the Secretary to the G.P.O. which appeared in the Press on October 16 and which has undoubtedly created a false impression in the minds of a certain section of the public.

Percentage Comparison Fallacious and Misleading.

(1) I wish to make it clear that while the manufacturers of bronze wire naturally regret the loss of this order, they regret still more the statements which have been made public by the General Post Office implying that the manufacturers of bronze wire have been guilty of an attempt to obtain public contracts at an unreasonable price. Such statements seriously reflect upon the manufacturers concerned, and have an unfortunate effect upon the other classes of business which they carry on. The manufacturers wish to state categorically that an unreasonable price in their opinion can only have one meaning, *viz.*, that it is so high as to create an unreasonable level of profits for the contractors. The definition now offered by the G.P.O. appears to be that the British manufacturers' price is unreasonable if his foreign competitor can quote a lower one. The Post Office's comparison between the prices quoted by British and foreign manufacturers gives the impression that there is a difference of between 30 per cent. and 40 per cent. in favour of the latter in the prices for the finished product, whereas these percentages are based on a calculation which omits the cost of raw material. When translated into terms of the actual price to be paid by the Department the facts are that the foreign prices were from £92 10s.— £93 10s. per ton, against the British price tendered of £102 per ton. The difference, in other words, is not 35 per cent. to 40 per cent., but approximately 8½ per cent., which difference is more than accounted for by the lower labour costs of the foreign manufacturers. The price which was refused by the British firms was about £97 per ton, but as I stated in my previous letter to the Postmaster-General, at the price tendered the profit to the British manufacturer was 3½ per cent., as proved by an auditor's certificate. As this omitted any allowance for overhead charges, the price which the British firms tendered would have represented a loss which they were willing to shoulder in order to keep their workpeople in employment.

Arrangement Has Benefited G.P.O.

(2) The letter from the General Post Office further attacks the principle of collective negotiation, and suggests that this is responsible for forcing the public to pay an unreasonable price. The facts are that the bronze wire trade is a small one, as there is practically no demand for this commod-

ity except from the G.P.O. Only six firms have been induced to take up the production, and the practice has been for consultation as to price to take place between the officials of the G.P.O. and these firms before formal tenders are sent in. This practice has in fact been for years the recognised basis upon which the Post Office has placed orders for the material in question. It has been approved even if it was not actually suggested by the G.P.O. as is shewn by a letter dated June 21, 1923, from the Controller of Stores, in which he states that the figures of works costs have been put before him which tend to show that prices discussed included only a reasonable addition to the actual cost of manufacture, and that it should be possible to arrange a definite contract if formal proposals were submitted on these lines.

With regard to the suggestion that the manufacturers' costs are unreasonable and might be reduced by concentration of production at one factory, it can be definitely stated that if the whole contract were placed with one firm, the possible reduction in cost would be negligible. Further, the policy of the Department has always been to insist on a plurality of suppliers, a policy which I venture to think has undoubtedly assisted the department to obtain economy and convenience in distribution, service and supply.

EVENTUAL INCREASE OF UNEMPLOYMENT.

(3) I should like to repeat that the result of the action of the Post Office in placing the orders abroad will be to increase unemployment, and had indeed already led to the diversion to foreign firms, of enquiries and orders which would normally be executed by British manufacturers. The eventual cost to the community will therefore be at least as great as the additional payment which would have been made by the Post Office if the order had been placed with British firms instead of abroad. The manufacturers, moreover, feel that in view of the Prime Minister's appeal to them to give further employment to the present unemployed, they have a reasonable right to expect the Government Departments to do their share by placing orders, even at the slightly greater cost, due to the higher labour charges and heavier taxation, with British firms; and at least to refrain from publishing statements about British manufacturers which, as I have shown above, give a totally false impression and can only react unfavourably upon the unemployment situation by curtailing orders to those manufacturers from other sources.

NICKEL IN CAST IRON.

The influence of nickel on iron-carbon-silicon alloys containing phosphorus has been studied as part of an investigation in progress under the auspices of the British Cast Iron Research Association.

Section I. of the paper deals with the laboratory preparation and testing of a series of alloys in which American washed iron was used as base. Two silicon and three phosphorus concentrations were selected, *viz.*, silicon 1.2 and 2.5 per cent. and phosphorus 0.2, 0.5 and 1.2 per cent. To the resulting alloys nickel was added in amounts of 1, 2, and 3 per cent., giving a total of 24 compositions.

The following conclusions are drawn from the results of the detailed examination to which the alloys were subjected :—

Phosphorus renders the low-silicon irons very susceptible to chill, 1.2 per cent. producing a white fracture in ½ inch sections of the iron. The addition of small quantities of nickel, by counteracting this tendency to chill, restores the grey fracture to this iron in all sections. Phosphorus has less effect on the chill of high-silicon iron, indicating that silicon, like nickel, opposes the effect of phosphorus. Nickel has a refininfi effect on the size of grain in the grey fractures of the iron.

Phosphorus has also a very deleterious effect on the machinability of iron and in the presence of the amounts of phosphorus under consideration in this paper nickel has little effect on this property.

Phosphorus reduces the amount of graphite in the low-silicon irons : nickel, on the other hand, will regraphitise this iron. In all irons which are completely graphitised nickel will render the graphite finer.

Further experiments were made using a commercial refined iron as base, the nickel and phosphorus concentration being similar to those used in Section I.

The conclusions drawn from these experiments confirmed those resulting from Section I, namely, that phosphorus increases the hardness of the iron, increases its tendency to chill and renders it difficult to machine. In the absence of chill, nickel produces its normal hardening action. Under conditions likely to produce chilled iron, nickel counteracts the chilling effect of the phosphorus. Phosphorus tends to reduce the influence of nickel on the iron and more nickel is required to produce a given result in the presence of high phosphorus, when there is any tendency to chill, than would be required in the presence of lower phosphorus.

A study has been made of the magnetic properties of cast iron, with special reference to its employment in the electrical industry.

Using a specially pure iron as base, the effect of varying percentages of silicon, phosphorus, cobalt and nickel was investigated, the nickel ranging from 0.71 to 18.83 per cent. through a set of eleven compositions. The addition of nickel decreases the magnetic induction and permeability of cast iron until at 15% nickel it becomes practically non-magnetic; increasing the nickel beyond this proportion results in comparatively slight alteration in the permeability values. Photomicrographs are included in the paper, showing that the permeability of the nickel-bearing iron decreases as the matrix becomes increasingly austenitic and that when an entirely austenitic structure is obtained the permeability is reduced to zero.

The electrical resistance of cast iron is increased by the addition of nickel; the author shows values rising progressively from 44.20 microhms per cm. cube at 0.71 per cent. nickel to 134 microhms per cm. cube with a nickel content of 18.38 per cent.

RAPID INCREASE IN CANADA'S COKE PRODUCTION.

For the third month in succession a new record has been established in coke production in Canada. For July the output of 200,016 tons represented a gain of 3 per cent. over the previous high record in June, 4 per cent. over May and 24 per cent. over July of a year ago, when 161,909 tons were produced.

The report of the Dominion Bureau of Statistics records a production of coke in Canada for the seven months of the year to date as 1,295,207 tons compared with 1,193,578 tons in the corresponding period of last year. Imports of coke were also higber at 530,310 tons compared with 403,501 tons last year and exports were down from 51,598 tons to 15,890 tons. This makes an apparent consumption of coke in Canada in the seve months of 1,809,627 tons compared with 1,545,481 tons last year.

During July coke charges to iron blast furnaces in Canada amounted to 97,464 tons. This compares with 63,398 tons in the corresponding month of last year. For the seven months of the current year to July 31 the total of coke consumed in this way was 613,105 tons compared with 512,139 tons in the corresponding period of last year.

PATENTS AND UNEMPLOYMENT.

British Science Guild Report on Patent Law Reform.

The British Science Guild's long-promised report on the reforms needed in the natent system is to be published in the course of this week. "Patents undoubtedly have a close bearing on the unemployment problem," said an official of the British Science Guild. "A good patent system tends to encourage inventions of the pioneer type—that is, inventions which break new ground, create new demands, and so absorb surplus labour—while it makes comparatively little difference to inventions of the 'improvement' type, which may create unemployment in certain circumstances by the fact that they cheapen production. On the other hand, a bad patent system may do harm all round by hampering industry. I think the proposals in the report will, if adopted, go far to remedy some of the well-known defects of our patent system, such as the grant of numerous invalid patents, the exasperating and costly delays which at present harass the inventor, and even to some extent the financial hardships which arise. The committee which drew up the report had some difficult problems to solve, but thanks largely to the patience of the chairman, Dr. Eccles, they have succeeded in thrashing out a considerable number of thoroughly practicable proposals."

THE SILVER-COBALT MINING INDUSTRY.

In 1927 there were 21 silver-cobalt mines producing, or shipping from old dumps. Of these 13 were operating in the Cobalt area, 5 in South Lorrain and 3 in the Gowganda district. The Nipissing mine was the principal silver producer in this group. Other large mines in order of production were—Mining Corporation, Keeley, Castle Tretheway, Frontier Lorrain and O'Brien.

The Nipissing Mining Company, Limited, was the only mining Company in Ontario producing refined silver in 1927. Other mines in the district shipped ore to the Nipissing mill, to the mill of the Cobalt Reduction Company, to the Deloro Smelting and Refining Company, and to foreign smelters.

The output of ores from these mines was 303,134 tons; the quantity milled amounted to 304,534 tons and the concentrates produced totalled 5,533 tons. There were 78,838 tons cyanided; silver bullion production from the cyanide process amounted to 1,927,529 fine ounces and silver produced

by the direct smelting of nuggets, 126,462 fine ounces.

Shipments of ores and concentrates to Canadian smelters amounted to 3,793 tons and to European and United States smelters, 2,714 tons, a total of 6,507 tons in 1927, as against 7,752 tons in 1926. The total value of shipments including bullion was $4,760,546 as against $5,470,433 in 1926.

Capital employed in the silver-cobalt mining industry in 1927 amounted to $30,123,645, of which $23,815,697 was invested in lands, buildings, plant machinery and tools, $1,024,241 represented cost of supplies and stock on hand, and $5,283,707 was in cash, trading and operating accounts and bills receivable.

Salaried officials numbered 109 in 1927 as against 156 in 1926. Wage-earners averaged 1,349 persons, of whom 860 were employed underground, 284 on the surface and 205 in the mills. Salaries and wages totalled $2,178,163. Fuel used cost $472,548 at the mines, which sum included $309,338 for electric power. Power equipment employed exclusve of boilers, consisted of 228 units, having a total rating of 8,909 h.p. Boilers numbered 20 with a total rating of 1,450 horse-power.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Applications for Licences in October, 1928.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 773, of which 606 were from merchants or importers. To these should be added 15 cases outstanding on the 29 September, making a total for the month of 788. These were dealt with as follows :—

Granted—713 (of which 696 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—62 (of which 50 were dealt with within 7 days of receipt).

Outstanding on 31 October—15.

Of the total of 788 applications received, 746, or 95 per cent., were dealt with within 7 days of receipt.

F.B.I. TRADE FORECAST.

The outlook continues unsettled, but with the prospect of improvement in the New Year. The dominant factor responsible for this unsettlement continues to be the international monetary situation.

Looking to the future, there are many indications that the Bank of England may soon be in a sufficiently strong position to exercise something more nearly approaching her pre-war freedom of action. We anticipate, therefore, that from now onwards the actions of the New York Federal Reserve Bank will become of less conseqnences, so much so that, unless there is an abnormally drastic restriction of credit in America, there is no reason why the New Year should not see a considerable easing of our internal monetary position, accompanied even by a reduction in the Bank Rate. We do not, however, look for any change in the present level of industry until the next few critical weeks have been safely surmounted.

INTERNATIONAL CONFERENCE FOR THE LIMITATION OF EXHIBITIONS.

The British Government is sending delegates to an international conference which opened in Paris on the 12 November for the purpose of discussing the question of the limitation and regulation of the number of international exhibitions and for concluding an international convention on the matter. A convention on this subject was signed at Berlin in 1912 but owing to the outbreak of war before ratifications had been exchanged, the convention never came into force. The main object of the conference will be to seek to limit strictly the long period general exhibition, which is organised in many cases primarily for sentimental reasons, and where the commercial results likely to accrue to participants do not repay the cost of sending a creditable exhibit. It is understood that the British Government takes the view after consultation with trade interests, that the short period trade exhibition or fair stands in a different category and in the main is a valuable aid to business.

The British delegates are Sir Edward Crowe, C.M.G., Comptroller-General, Department of Overseas Trade, Colonel H. W. G. Cole, C.S.I., Director, Exhibitions Division, Department of Overseas Trade, Mr. J. R. Cahill, C.M.G., Commercial Counsellor, British Embassy, Paris. The delegates will be accompanied by Mr. W. E.

Beckett, Assistant Legal Adviser, Foreign Office, Mr. Guy Locock, C.M.G., who has been nominated by the Federation of British Industries, and by a representative of the Association of British Chambers of Commerce, and by Mr. L. A. de L. Meredith, O.B.E., and Mr. A. I. Schué of the Exhibitions Division, Department of Overseas Trade.

OVERSEAS TRADE.

H.M. Consul-General at Lourenço Marques (Mr. Joseph Pyke) reports that the Tendering Department of the Treasury are calling for tenders, to be presented by the 17 January, 1929, for the supply and delivery of 15 complete (bacteriological) laboratory sets.

Firms desirous of offering equipment of British manufacture can obtain further particulars of this call for tenders on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference B.X. 4848 should be quoted.

The British Vice-Consul at Lima (Mr. J. V. K. Dible) reports by cable that an Hygienic Exhibition is to be held at Lima from the 25 November to the 10 December, 1928. The exhibits are to comprise medical, chemical, sanitary, surgical, dental, and allied products.

SILVER MINING INDUSTRY IN CANADA IN 1927.

Silver mining is not a distinct industry in Canada, as silver is found only in association with other metals; with lead and zinc, particularly in Western Canada, with cobalt in northern Ontaria, and with lode and placer gold, copper and other metals in various localities. Industrial reviews concerning the production of silver involve consideration of the various sources of supply, and general statistics on this subject should relate to each of the contributing sections of the mining industry. Silver-lead-zinc mining is a very important industry in British Columbia, the Yukon Territory, Quebec and, to a less extent, in Ontario, whereas the mining of silver-cobalt ores is carried on in Canada only in the province of Ontario. While silver is the predominating metal in some ores of the silver-lead-zinc group, there are other mines which yield an ore carrying lead and zinc in greater values, so that the silver content is of secondary importance. Silver values are the governing feature in the silver-cobalt ores of Ontario. Alluvial and lode gold and ores containing copper and gold usually contain commercial values in silver also, but in these ores the metals other than silver are generally of greater importance.

PRODUCTION OF SILVER, LEAD, ZINC, COBALT AND ARSENIC.

In 1927 the total production from Canadian ores of all kinds included 22,736,698 ounces of silver valued at $12,816,677; lead 311,423,161 pounds worth $16,477,139, zinc 165,495,525 pounds worth $10,250,793, cobalt, 880,590 pounds worth $1,764,534, and arsenic, the greater part of which is recovered from the silver-cobalt ores of Ontario and the remainder from the arsenical gold ores of British Columbia and Nova Scotia, 6,227,968 pounds worth $211,979.

Among the metals and minerals produced in Canada lead holds fourth place, silver seventh place and zinc tenth place in point of value. In 1927 Canada ranked third among the world's silver-producing countries, fourth among those producing lead and sixth in smelter output of zinc. In the output of cobalt Canada and Central Africa produce about equal amounts.

THE SILVER-LEAD-ZINC MINING INDUSTRY.

Silver-lead-zinc ores are found in commercial quantities in the provinces of Quebec, Ontario, British Columbia and the Yukon Territory. Ores from the Tetreault mine in Quebec are concentrated and exported for treatment to Belgian and the United States smelters. Galena ore from Galetta, Ontario, is concentrated and smelted at the mine; and high grade ores and concentrates are exported to United States smelters from the Mayo district of the Yukon.

In British Columbia, where the greater part of this industry is carried on, the Trail smelter handles all concentrates from the Sullivan mine as well as from other mines within reasonable shipping distance. In addition to the smelter a customs concentrator is also operated and thus much assistance is rendered small producers.

In 1927 British Columbia held first place among the provinces of Canada in output of silver, lead and zinc. In this Province 48 per cent. of Canada's silver, 94 per cent. of the lead, and 89.5 per cent. of the zinc were produced. The Sullivan mine, noted the world over for its output of lead and zinc, is the largest individual silver-producing mine in Canada.

The silver-lead-zinc mining industry was represented by 172 mines operated by 157 concerns in 1927. In Quebec 5 properties were operated, one of which was producing. In Ontario 3 mines were in the development stage and 1 was producing. In British Columbia 146 mines were being worked, 110 of which were producing, and in the Yukon 17 mines were reported on the producing list.

Ore mined during 1927 totalled 1,763,660 tons, and 1,914,101 tons were milled. Shipments of lead ores, lead concentrates, zinc ore, zinc concentrates and dry ores from the mines amounted to 490,846 tons valued at $17,520,130. As determined by settlement assay, the total metal contents of these shipments included 22,510 ounces of gold, 9,664,673 ounces of silver, 321,092,812 pounds of lead and 226,362,997 pounds of zinc. Capital employed in this industry in 1927 amounted to $28,036,330 and included over 20 million dollars invested in lands, buildings, plant, machinery and tools, 2 million dollars in the value of supplies and stock on hand, and nearly 5.5 millions in cash, trading and operating accounts and bills receivable. Salaries totalling $468,827 were paid to 229 people, and wages amounting to $4,338,990 were distributed among 2,877 workers. Fuel used amounted to $588,520. Primary power employed consisted of 465 units with a combined rating of 29,274 h.p. Secondary power consisted of 52 motors rated at 1,411 h.p. There were 38 boilers in use rated at 4,225 h.p.

MOND NICKEL COMPANY.

On and after Monday, 12 November, 1928, the Head Office of the Company will be at :— Imperial Chemical House, Millbank, London, S.W.1. Telephone, Victoria 4444.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, November 8 :—

Investigations on the Cell-Wall Substances of Plants, with Special Reference to Lignification. By S. B. SCHRYVER, F.R.S., AND E. J. CANDLIN.

Substances accompanying cellulose in plant cell-walls may be divided into 3 classes : (i) lignins, (ii) hemicelluloses, (iii) pectins. Products belonging to two latter classes are formed by conjugation of sugar acids (glycuronic and galacturonic acids) with sugars. These acids are designated "uronic acids," and hemicelluloses and pectins appear, therefore, to belong to a distinct chemical group, for which the name "polyuronides" is suggested.

Pectins contain much larger uronic acid content than do hemicelluloses, while uronic acids are absent from lignins. Lignified tissues contain lignins and hemicelluloses in relatively large amounts, with only traces of pectins. Non-lignified tissues, on the other hand, contain relatively large amounts of pectins, small amounts of hemicelluloses, and no lignin.

Pectins undergo decarboxylation on treatment with weak alkaline solutions, even at room temperature, yielding among other products, hemicelluloses, still containing uronic groups, but resisting decarboxylation on treatment with alkalis, and resembling in all respects hemicelluloses isolated directly from timbers. Results indicate that decarboxylation takes place when plant tissues lignify.

Chromosome Linkage in Certain Oenothera Hybrids. By R. R. GATES AND F. M. L. SHEFFIELD. Communicated by Sir John Farmer, F.R.S.

An account is given of 5 generations of hybrids from *Oe.* (*biennis* × *rubricalyx*) × *ammophila* and *Oe. ammophila* × (*biennis* × *rubricalyx*) and their cytological peculiarities. The chromosome linkages appear to be a means of explaining some of the genetic behaviour observed in these and similar hybrids. Reciprocal F_1 hybrids are very different. They are patroclinous. It may be that the Oenothera linkage arose between non-homologous chromosomes. It appears probable that a relation exists between the chromosome linkage and the genetic linkage which is a characteristic feature of the genus.

Experiments on the Physiology and Genetics of the Smut Fungi. By S. DICKINSON. Communicated by V. H. Blackman, F.R.S.

The Smuts Fungus used was the Covered Smut of Oats (*Ustilago levis*). After isolating a chlamydospore and allowing to germinate on suitable medium, the first sporidium formed by each of the four segments of its promycelium was isolated, transferred to test-tube slopes, and allowed to develop. Four cultures of strains were obtained from one chlamydospore. This has been repeated with a number of chlamydospores of known parentage.

The strain obtained from any one was found to differ from the other three strains. The segregation of these cultural characters was found to be on a 2 : 2, 3 : 1 and 4 : 0 basis. It is deduced that this segregation may take place in either the first or the second of the "reduction divisions."

No conclusive evidence of somatic segregation has yet been obtained, the strains remaining constant during the time in culture. The cytoplasm has no determining influence on cultural characters so far described.

The Mechanism of Secretion in the Thyroid Gland. By R. J. Ludford and W. Cramer. Communicated by J. A. Murray, F.R.S.

The cells of the thyroid discharge into the lumen of a vesicle and so into the blood stream. There is no alteration of direction of discharge during prolonged increased functional activity. There is no evidence that the cells secrete normally direct into the capillaries.

In exophthalmic goitre, in mouse and man, there is enlargement of mitochondria and of Golgi apparatus—a condition characteristic of intense secretory activity. The polarity of the Golgi apparatus is frequently reversed. The secretion droplets, formed in association with the reversed apparatus in the case of the mouse are discharged direct into the capillaries.

Secretion in the thyroid in exoph. goitre therefore differs from that in normally active gland, in the direction in which the specific secretion discharges. Normally, discharging first into the lumen of the vesicle, in exoph. goitre there is direct discharge into the capillaries. The authors explain this pathological condition on the basis of this difference in the mechanism of secretion.

The following papers were read in title only :—

Some Further Studies in the Development of the Skeleton in Echinoderms. By Isabella Gordon. Communicated by E. W. MacBride, F.R.S.

(A.) *Arbacia punctulata* Gray.—The test of the imago is bilaterally symmetrical about Uebisch's primordial plane of symmetry. The young arbocioid triad consists of two primary plates, followed by a demiplate. The orad primary is later reduced to a demiplate. The inter-ambulacrum of the imago consists of one row of three plates, the median one alone reaching the peristome. The inter-ambulacrum of young *Arbacia* is similar to that of adult *Habrocidaris.*

(B.) *Echinarachinus parma* Lamk.—In the imago the anterior is more advanced than the posterior end of the test. Genital 1 is absent; the larval spicules which should give rise to genitals 3 and 5 are resorbed; genitals 2 and 4 apparently fuse to form a single pentagonal plate.

(C.) *Leptasterias æqualis Stimpson.*—The early development of the skeleton, essentially similar to that in *Asterias,* is in some respects more like that in *Asterina,* which also has a yolky ovum.

A Study of the Adrenal Cortex in the Mouse and its Relation to the Gonads. By Ruth Deanesly. Communicated by J. P. Hill, F.R.S.

The historical difference between adrenals of male and female mice has been investigated and its development traced. Well-marked normal changes are described in the cortex of the female gland. These show no correlation with œstrous cycle in unmated animal. Pregnancy accelerates these normal changes, but has no specific effect on structure of gland.

In the castrated male an adrenal of female type develops. Ovariotomy has no effect on adrenal. Double adrenalectomy was performed on a number of male and female mice; these bred normally after operation.

The histology of adrenals of mice is discussed in relation to those of man and other mammals.

Anatomy and Phylogeny of Spondylus, with a Particular Reference to the Lamellibranch Nervous System. By W. J. Dakin. Communicated by E. W. MacBride, F.R.S.

An investigation of the bivalve mollusc, *Spondylus,* was undertaken in order to determine the relationship of this genus to *Pecten.* The desirability for information on this subject arose from the fact that *Spondylus* possesses eyes of a type almost or exactly the same as those of *Pecten,* though the habits of the two genera are very different. *Spondylus* lives fixed by its shell to submerged rocks, etc.; *Pecten* moves abont actively and is able to swim.

The investigation indicates that anatomically *Spondylus* is not only a close relative of *Pecten,* but that its structure can be best interpreted by asssuming it derived from a form not unlike *Pecten maximus.*

An unexpected discovery was made in the nervous system, which differs remarkahly from the type so familiar in all other Lamellibranchs. The pedal ganglia are connected by long nerves to the visceral ganglion and cerebro-pedal connectives are [illegible] ves. A theory is

provided to explain this nervous system, based on conditions present in *Pecten*. The results of the study are in agreement with palæontological evidence and with information concerning shell development.

The Eyes of Pecten, Spondylus, Amussium and Allied Lamellibranchs, with a Short Discussion on their Evolution. By W. J. DAKIN. Communicated by E. W. Macbride, F.R.S.

The author has examined the eyes of a series of rare genera of Lamellibranchs, in order to obtain facts which might help in elucidating the evolution of the eyes of *Pecten*. The eyes of *Pecten*, *Spondylus*, *Amussium*, *Chlamys* and, in all probability, *Pedum* may be considered identical in structure. No Lamellibranchs outside the suborder Pectinacea have eyes of the same type, and within the group the eye structure is remarkably constant, notwithstanding the diversity in habits of the animals.

The development of the eye throws little or no light upon its evolution. Evidence is brought forward in support of the view that the eyes in the Pectinacea are functionally not so highly developed as their complex structure might lead one to suppose. It is suggested that Internal Factors have played a greater part in their evolution than Natural Selection.

Artefacts as a Guide to the Chemistry of the Cell. By C. E. WALKER. Communicated by Sir John Farmer, F.R.S.

It is suggested that, by observing appearances in fixed material and comparing these with similar appearances in films and drops of mixtures ,of known composition, treated in the same way, the nature of some chemical and physical states in parts of individual cells in dicerent conditions may be elucidated.

Experiments described show that when mixtures containing albumen, peptonate, gelatine and lipins, with minute globules of methyl myristate or laurate suspended in them to act as artificial nuclei, are suitably fixed and treated with osmic acid, lipins separate out and are deposited, largely near to the globules, and are blackened. If, however, yellow phosphorus be dissolved in the myristate or laurate, the greater part of the lipins is deposited upon the actual surface of the globules. This suggests that nuclear content may determine position in which lipins are fixed.

If these mixtures, with myristate or laurate containing phosphorus, are kept at a temperature of 30° C., lipins appear to become gradually saturated or oxidised and apearances on fixation resemble the changes described as occurring in "Golgi apparatus" in cells of animals suffering from phosphorus poisoning.

THE INSTITUTION OF CIVIL ENGINEERS.

INAUGURAL ADDRESS OF SIR BRODIE HALDANE HENDERSON, K.C.M.G., C.B., PRESIDENT, 6 November, 1928.

The President recalled that his predecessor, Mr. Trench, on taking the chair, had expressed his keen regret that Sir Archibald Denny, the senior Vice-President, on account of ill-health, had asked that his name should not be put forward for election to the Presidency. Sir Archibald still felt unable to discharge the duties of that office; and the President could only re-echo the sentiments expressed by Mr. Trench.

The remarkable progress made in transport in recent years was well worthy of consideration; he therefore had selected that branch of engineering as the subject of his Address, and he would confine his remarks to transport by land. Roads were the most ancient aids to land transport. Some of the earliest roads were very substantial, and in many of them were still visible the ruts caused by the runners and wheels of vehicles. Many were so narrow that passing places had had to be provided, which had much the appearance of passing-places on railways, the ruts corresponding to the rails. It had been computed that during the Roman occupation of Great Britain there were at least 8,000 miles of good roads in the country.

To-day there were 180,000 miles of highway, of which 25,000 miles were Class I roads. The rapid growth in road-traffic and the increase in loads and speeds presented serious problems to the road engineer. The recent establishment of a Chair of highway engineering was an indication of the scientific study now devoted to the subject. It was a question whether the increase in road-traffic would lead to a point of saturation, so that the railways would again have to relieve the roads. The probable outcome was that both would continue to serve a useful purpose.

Railways were still the greatest instruments for the movement of goods and passengers on land. The question of gauge had probably been settled in most countries, and there were sound reasons for the adoption of the different standards. The 4ft. 8½in. gauge, which made up 56 per cent. of the total mileage of the world, was broad

enough for high speeds and for powerful locomotives and adequate rolling stock, and at the same time it allowed reasonably sharp curves to be used. Broader gauges were generally adopted only in countries where construction was simple. The metre gauge was useful where low first cost was important and where broken country had to be traversed. Figures for area and population of various countries in relation to railway mileage showed that there was still a vast field for railway construction in different parts of the world.

Works in connection with transport in foreign countries had been very largely undertaken by British engineers, and he would refer to them rather than to work within the Empire, which was so well known.

The city of Buenos Aires, Argentina, had grown, within the memory of many still living, from a small and inaccessible municipality to one of the most up-to-date cities of the world, with a population exceeding 2 millions. One of the earliest needs of that city had been access for shipping, and in 1885 Messrs. Hawkshaw, Hayter and Dobson designed a system of docks along the foreshore, giving a quayage of 27,800 feet. There were now further docks, which had increased the total quayage to 56,300 feet; and very extensive reclamation had been carried out. A feature of the port was the dredged approach-channels, aggregating 18 miles in length.

Bahia Blanca, 400 miles south of Buenos Aires, was an important port which exported over 2 million tons of grain in 1927. To the north of Buenos Aires was the port of Rosario, at which the Central Argentine Railway alone shipped 4.6 million tons of grain in the same year.

The capital of Brazil, Rio de Janeiro, was situated in a practically land-locked bay. The harbour improvements at that port, carried out by Messrs. C. H. Walker and Company, consisted of a quay-wall 11,500 feet long founded on steel caissons in about 38 feet of water, with a maximum foundation-depth of 72 feet below high water.

Northward along the coast were numerous harbours, many of which had been constructed by British engineers, and the same applied to the north coast of the continent. Among the numerous port and harbour works on the west coast the most noteworthy was Valparaiso, which was situated in an exposed bay, bordered by hills running practically to the water's edge. The works begun in 1912 by Messrs. S. Pearson and Son, Ltd., had already been described before the Institution, their chief feature being the depth of water in which the breakwater and quays had been constructed. An extension of the breakwater was now in progress, being composed of 40- to 60-ton blocks on a mound in 175 to 190 feet of water.

Important railways had been build in Argentina with British capital, under British engineers, and with British materials. The total mileage was 29,000 route miles, and the country could be divided into three zones—the southern, western, and northern—served respectively by the Buenos Aires Great Southern Railway; the Buenos Aires Western and the Buenos Aires and Pacific Railways; and the Central Argentine and the metre-gauge Cordoba Central Railways. The broad-gauge main lines had 100-lb rails, and in some sections chaired roads were used. A difficulty was the scarcity of stone, which had led to the general use of earth ballast. In recent years, however, a great deal of stone ballast had been introduced. Taking the two biggest railways together, namely the Buenos Aires Great Southern and the Central Argentine Railways, which had their termini in Buenos Aires, the total mileage was 8,025, and the capital invested was £124,000,000.

The President then described briefly various railways in South America, including the metre-gauge line crossing the Andes and connecting Argentina with Chile; the railway from the port of Antofagasta to Bolivia, which crossed the great plateau 13,000 feet above sea-level; the Southern Railway of Peru; and the Central Railway of Peru, which rose from the port of Callao to a height of 15,806 feet in 109½ miles.

The works he had described touched only on the fringe of the subject of the vast field for British engineering enterprise abroad. In addition to harbours and railways, there were tramways, waterworks, sewerage, electricity, and hydro-electric undertakings. So long as such countries continued to develop with the aid of British capital, they would afford work for British engineers and manufacturers. In more highly developed countries the specialist might find ample scope; but in countries undergoing vigorous development the man trained on broad lines was more likely to be successful. The Institution Diploma was held in high repute in South America and elsewhere, because it was a guarantee of engineering knowledge, training and experience of a fundamental character, and of a good standard of general education.

Many problems still faced the railway engineer. For example, if steel sleepers could be adopted in Great Britain, the money spent on foreign timber for sleepers would be diverted to the steel manufacturers. Another question was the working of branch lines with light traffic. Steam rail-cars were used in Great Britain, while abroad the oil-engine had been successfully used for that service. With regard to operation, while electrification had not given in every case the financial advantages expected, its convenience to passengers left little to be desired. Permanent way was being gradually improved in all countries, and the heavy rail was being widely adopted, not only to take heavier axle-loads, but also on account of the smoother running it gave, with a consequent reduction in maintenance charges for both road and rolling stock. The present trend was towards more powerful locomotives, which were particularly suitable for countries where oil fuel was used. Special steels were being increasingly used, and more efficient valve-gears were being tested. The super-heater, of course, was now in almost general nse. In one aspect of bridge-design Great Britain seemed to lag behind practice elsewhere, namely in the use of special steels, and he thought that there was a useful field for inquiry in that matter.

He had shown that engineers were alive to the requirements of modern transport and were striving in every direction for higher efficiency; but their work could not bear fruit without the co-operation of the managerial side of railway enterprise. High authorities stated that the period of trade depression was coming to an end, and he was confident that the members of the Institution would be ready and able to fulfil their duties in connection with such a revival.

ROYAL SOCIETY OF ARTS.

Swiney Prize for Work on Medical Jurisprudence.

The next award of the Swiney Prize—a silver cup of the value of £100 and money to the same amount—to the author of the best published work on Medical Jurisprudence will take place in January, 1929, on the 85th anniversary of the testator's death. The award is made jointly by the Royal Society of Arts and the Royal College of Physicians, and any person desiring to submit a work, or to recommend any work for the consideration of the Judges, should do so by letter addressed to the Secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.2., not later than November 30, 1928.

The Silver Cup to be presented on this occasion was designed by Mr. Edward N. H. Spencer, whose design was awarded first prize at the Society's 1928 competition of industrial designs. The finished cup has been included with the works of living craftsmen which forms part of the Loan Exhibition of Oxford College Plate on exhibition at the Ashmolean Museum, Oxford, from November 7 to November 28.

THE PHYSICAL SOCIETY.

A meeting was held on November 9, at the Imperial College of Science. The following papers were read :—

The Effect of Moist Air on the Resistance of Pencil Lines. By J. B. Seth, M.A., Chetan Anand, M.A., and Gian Chand, M.Sc.

The resistance of a pencil line is found to increase when it is kept in a moist atmosphere. The change in resistance for different degrees of moisture is investigated and a suggestion is made that this change may, under certain circumstances, be utilised to measure humidity.

An Absolute Current-balance Having a Simple Approximate Theory. By L. F. Richardson, D.Sc., F.R.S., V. Stanyon, B.Sc., and other Students of Westminster Training College.

A simple form of current balance has been constructed which, when tested by experimental comparison with a standard ohm and Weston cell, measures currents with a probable error of about 1 part in 1,000. The calculation of the force acting on the moving coil of the balance involves no pure mathematics beyond that of the intermediate B.Sc. The coils are single layers so that they can in the future be made as precise helices. Actually we have had to aim at cheapness rather than at perfection, and so irregularities of shape leave the current uncertain by 5 parts in 1,000. A second approximation, depending on a simple deduction from Laplace's equation, corrects the elementary theory by 1.4 parts in 1,000 of current.

Notes on Wireless Methods of Investigating the Electrical Structure of the Upper Atmosphere. I. By E. V. Appleton, F.R.S.

Various direct wireless methods of measuring the "effective" height of the atmospheric ionised layer are discussed and compared. For a layer of horizontal stratification, and under conditions for which the influence of the earth's magnetic field may be neglected, the general equivalence of the quantities measured by the various methods is demonstrated. The effective height in such cases is shown to be greater than the maximum height reached by the atmospheric ray. Proposals for using these methods to obtain information concerning the gradient of ionisation in the layer are put forward.

Proceedings at the meeting held on October 26, 1928 :—

W. H. Eccles, D.Sc., F.R.S., and subsequently R. W. Paul, in the chair.

A paper entitled *An Experimental Study of the Anticlastic Bending of Rectangular Bars of Different Cross-Sections*, by Allan Ferguson, M.A., D.Sc., and Jas. P. Andrews, M.Sc., was read by Mr. Andrews.

A paper entitled *An Instrument for the Production of Known Small High-Frequency Alternating Electromotive Forces*, by B. S. Smith, A.M.I.E.E., F.Inst.P., and F. D. Smith, M.Sc., A.M.I.E.E. was read by Mr. F. D. Smith.

A Demonstration of a New Device for Thermostatic Control was given by H. F. T. Jarvis, B.Sc., Birkbeck College.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on Monday, November 5, Sir Arthur Keith, Treasurer and Vice-President in the chair. Mr. E. R. Debenham, Mr. Alfred Fowler, Lord Gorell, Miss C. M. Lydall, the Earl of Plymouth and Mr. A. S. P. White-Cooper were elected Members.

NOTICES OF BOOKS.

Practical Color Simplified. By William J. Miskella. Pp. xiv + 114. With charts. U.S.A. Chicago: Finishing Research Laboratories. 1928.

This interesting book on Colour contains all important information on the choosing, mixing, matching and harmonising of pigments and paints. In addition it gives valuable details about such matters as colour lighting.

From the scientific view point it traces the development of our knowledge of the nature of colour from Newton's analysis of white light to the latest modern physical developments. Colour Photography is touched upon and reference is made to colours which it is still difficult to reproduce photographically.

The question of nomenclature is a difficult one and no reference is made to Ostwald's views but the author has put forward views and schemes of his own, largely resulting from technical experience. The charts which are well executed are of special value to technologists concerned with paints, pigments and allied branches of applied chemical science.

A feature of the volume is that its binding "is water-proof, vermin-proof, and highly resistant to wear." It merits the attention not only of the specialists interested in the subject but also of the general reader who desires information concerning Colour and pigments.

A Survey of Nitrocellulose Lacquer. By B. K. Brown and F. M. Crawford. Pp. 368. New York: Chemical Catalog Co. 1928. Price $7.50.

The tremendous developments of the nitrocellulose lacquer industry in recent years and the newer applications of the products has tended to obscure the fact that these products have been in use for some decades. The authors have now made a survey of the subject aud compiled an invaluable bibliography of books, pamphlets, patents and communications in the scientific and technical literature of nitrocellulose lacquers. There is also an introductory section dealing with solvents, diluents, viscosity, evaporation, etc.

Industrial Chemistry. By E. R. Riegal, Ph.D. Pp. 649. New York: Chemical Catalog Co. 1928. Price $9.

This comprehensive volume is intended to give a picture of the numerous commercial activities which make up modern industrial and applied chemistry. Beginning with chapters on sulphuric acid manufacture the author describes the heavy chemical industries and goes on to an account of the latest developments in the fixation of nitrogen, distillation of coal, the glass industries, electrochemical processes, industrial gases, cellulose industries, sugar and its refining, dyes, soap, explosives, the metals and, not least important, the plant used by the chemical manufacturers.

Forthcoming Events.

ROYAL INSTITUTION.

Tuesday, November 20, at 5.15 p.m.—" Diamonds." By Sir William Bragg, F.R.S.

Thursday, November 22, at 5.15 p.m.—" The Mechanism of the Nerves." By Dr. D. D. Adrian, F.R.S.

ROYAL MICROSCOPICAL SOCIETY.

A meeting will be held in the Lecture Hall at the above address on Wednesday, 21 November, at 7.30 p.m. The following papers will be read and discussed :—" Ovule Development and Meiosis in *Orobanche minor.*" By Miss Kathleen M. Carter, M.Sc. ' Tripod and Pillar Microscopes." By Dr. W. H. Van Seters.

SOCIETY OF GLASS TECHNOLOGY.

Meetings of the Society will be held in Stourbridge on Tuesday and Wednesday, November 20 and 21. Following is the programme :—

Tuesday, November 20, at 7.30 p.m..—Public lecture by Walter Butterworth, Senr., Esq., M.A., on " Byzantine and Venetian Glass."

Wednesday, November 21—

9.30 a.m.—Meeting of the Glass Standards Committee together with Joint International Technical Committee, in the Talbot Hotel.

10.30 a.m.—Meeting of Council in the Bell Hotel.

2.30 p.m.—General Meeting in the Talbot Hotel.

General Discussion on " Glassworks Refractory Materials." The subject will be introduced by Prof. W. E. S. Turner, who will speak on " Recent Progress in the Study of Refractory Materials for the Glass Industry." The following reports will be presented :

(a) " A Summary of Faults and Defects which may arise in the Manufacture and Use of Glasshouse Pots : Their Cause and Prevention." By P. Marson.

(b) "The Durability of Glasshouse Pots."

(c) " Memorandum on the Purification of Clay, Heat-Treatment of Pots and the Use of Sillimanite Pots." By Prof. W. E. S. Turner.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

30,719.—Kunstdunger - Patent - Verwertungs. Akt.-Ges. — Producing mixture of calcium nitrate and ammonia nitrate. October 23rd.

30,591.—Consortium fur Elektrochemische Industrie Ges. — Manufacture of acetone. October 22nd.

Specifications Published.

299,084.—Carpmael, A. — Apparatus for distillation, rectification, or evaporation.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

296,832.—Calcium nitrate, alumina, phosphorus, silica.—Johnson, J. Y., 47, Lincoln's Inn Fields, London.

A raw phosphate is fused in known manner with coaly matter and aluminous material such as bauxite, kaolin, clay, or loam to distil off the phosphorus, and the resulting slag is converted and separated into calcium nitrate, alumina, and silica. Preferably the process is so conducted that iron present is reduced and tapped out as a phosphite-bearing pig iron and the addition of bauxite, etc. so regulated that the slag obtained contains from 45-60 per cent. of aluminium and ferric oxide, from 10-40 per cent. of aluminium and ferric oxides, and from 30-10 per cent. of silica, since such a slag disintegrates on cooling and is readily decomposed by acids. The slag is treated with nitric acid to bring the calcium and aluminium into solution and the silica

sorbent or insulating material, or for agricultural purposes. From the nitrate solution the aluminium together with any iron is precipitated by milk of lime or calcium carbonate, preferably in the presence of a small percentage of compounds such as brown coal tar oils, coal tar oils, or tetrahydronaphthalene to reduce the bulk of the precipitate. From the remaining solution the calcium nitrate is recovered in solid form. An example of the treatment of a Moroccco phosphate is given.

The Latest TRADE MARKS

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ORIGIN OF THE HESS-KOLHÖRSTER RADIATION—COSMIC RAYS.

(*Concluded from Page 305.*)

It will be seen that Millikan and Cameron claim that the cosmic rays are "birth cries" of abundant elements when born out of hydrogen in the cold depths of interstellar space. The atoms so formed being mainly He, O, Si, and possibly Fe.

It was intimated in the previous part of this article that this process might occur only in nebulæ. Bowen (*Astrophys. Journ.*, 1928, 67, 1) has identified oxygen, nitrogen, carbon, and possibly calcium in nebulæ. While nebulæ are on the whole highly diffuse in structure, which means comparatively low pressure, the temperature due to radiation from stars within the nebulæ is evidently considerable. The spectrum lines observed show that electrons have been removed from the atoms. The presence of hydrogen and helium in nebulæ has been long known. Bowen suggests that electrons are removed from atoms by the photoelectric action of the light issuing from the stars and the nuclei of the nebulæ. If atoms are in the process of making in these remotely scattered regions of space, *i.e.*, in nebulæ, then the condition of extreme cold, bordering on the absolute zero, seems not to be fulfilled.

It appears to me that, if elements are being formed, the 'ordering' of so many protons and electrons must arise from some sort of vortex that tapers down, so as practically to be a wire-drawing process.

It will be remembered that Paneth and Peters in 1926 attempted to form helium from hydrogen in contact with palladium-black; that is to say, some of the absorbed or adsorbed hydrogen under the catalytic influence of palladium-black was supposed to unite to form a trace of helium. The experimental evidence was meagre and later on these investigators abandoned the idea. In this connection see *Chemical News*, 1928, 137, 241.*

It will also be remembered that Oxley (*Proc. Roy. Soc.*, 1922, 101, 264) found that when palladium-black absorbed hydrogen the paramagnetic susceptibility of the substance decreased sufficiently to suggest that some of the atoms underwent an internal change sufficient almost to form the next element silver. Silver is, of course, very slightly diamagnetic, so that in this case there was a change which brought palladium magnetically near to silver.

Here is suggestive evidence of a near transformation, but the final 'clamping' had not, evidently, taken place.

In these two experiments no great external pressure was involved.

* See Helium Investigations, by Paneth and Peters (*Zeit f. Phys. Chem.*, *B*, 1928, 1, 170). By a particularly sensitive method the statements in literature respecting a formation of helium as a consequence of artificial transformation of elements are tested. If the precautions indicated are followed no helium formation could be observed down to a quantity of the order of 10^{-10} cm^3.

Now nitrogen approaches in respect of its inertness the inactive gases, and the formation of NH_3 by direct contact of its elements (N_2 and H_2) can be accomplished with great pressure and a suitable catalyst, which is the basis of the well-known Haber process. The equilibrium yield in this case increases by lowering the temperature, while the speed of combination is increased when the temperature is high, but the catalyst must not be subjected to excessive heat, so that in practice an intermediate temperature is used.

In the case of combining protons with themselves to form elements it is natural to conclude that great pressure would be necessary, as the protons would have to be disarranged, very much as N_2 has to be broken up to form NH_3, but not, obviously, the same process in detail, though in both cases the action is exothermic.

This leads back to the vortex idea, or rather to the wire-drawing idea, which in a general way is somewhat the same.

Apart from problems in technique, which might be impossible to solve practically, if the palladium-hydrogen system could be compressed, by, so to speak, wire-drawing this pseudo compound, then there is the remote possibility of forcing the protons so close together that with electrons present helium might be formed; and, indeed, traces of silver might also be formed.

Now the question is Could any such state of affairs obtain in nebulæ? It seems at present difficult to imagine anything of this kind, but it must be remembered that this part of the discussion is largely in terms of analogy.

It is also to be noted that nebulæ are so far away that little is known about them. Even the light-emitting particles may be far larger than has been supposed; in fact, they may represent systems in themselves highly complex.

There is one feature of interest : the temperatures need not be, and are probably not, exceedingly high as compared with stellar interiors.

Millikan and Cameron insist on the conditions being diametrically opposite to those of stellar interiors, and this may, in a measure, be the case in nebulæ. Nebulæ and free space are made mutually inclusive, but I am inclined to adopt the view of Jeans that the cosmic rays only come from nebulæ.

These studies lead to some interesting considerations. If in the central region of a star—our sun for example—the protons and electrons are falling together and annihilating each other, as Jeans has suggested, then the very high frequency radiation so produced must be absorbed before it reaches the star's surface, for no high-frequency radiation appears to emanate from the sun. The absorption of so much energy would in turn increase the masses of those elements which absorbed it, if the Einstein-energy-mass theory works both ways, that is to say, is *reversible*. As a consequence, the outer elements in the sun should become heavier. For example, hydrogen (protons) in the centre of the sun just before disappearing into radiation might have a mass of, say, 1.000; and the same type of atom near to the sun's surface a mass of, say, 1.00778. If this be the case, then to calculate the loss of mass of a star by virtue of the annihilation of matter would require a correction to be made owing to a certain external gain in mass. The inner elements would be losing mass and the outer elements gaining in mass. Assuming ultimately an equilibrium state of mass, so to speak, this would level up the atomic weights and make matters worse, as will be seen from the following, so this feature will not be considered.

Now another question arises Would atoms thus gaining in mass, as a consequence gain in kinetic activity? If the gain in mass in this way was sufficient, the heavier elements at the sun's surface, or near thereto, would tend to fall back towards the sun's centre, and in so doing generate heat, but not enough to lose the mass gained. If this went on for a time there would be atoms of minutely varying mass, and this is not borne out by experiment, for terrestrial atoms are supposed to have been drawn out from the sun by a passing star, and they show no such minute variation.

This exchange in mass would not seem to account for isotopes unless the mechanism of mass-gain was subject to laws not known. That is to say, an atom could gain in mass up to a certain limit, but not beyond. Chlorine 35, for instance, could gain up to 37, it being assumed that sufficient time had elapsed for each gain to reach its whole-number limit. Again, a difficulty arises in this example. If chlorine 35 can gain up to Cl37 and there are 35's on the earth Why are there no intermediate masses on the earth as well? The gain surely could not be in whole-number jumps, for if this were the case then the basic scheme of Millikan and Cameron falls to pieces. The quantum theory would not suggest such enormous limiting quanta.

The conclusion here is that the process is not reversible, and therefore radiation cannot of itself create mass (matter), but the

units of matter may wholly or partly, according to circumstance, dissolve into radiation. While this phase of the subject is contrary to Millikan and Cameron's opinion, Jeans strongly favours this point of view—referring here to the part in italics.

The reader should bear in mind that the foregoing discussion refers only to the behaviour of energy *as radiation*, and not to protons and electrons uniting to form elements, as Millikan and Cameron's experiments seem to indicate, and which has been *explained earlier in this article*.

F. H. L.

CATHODIC POTENTIAL IN THE ELECTROLYSIS OF CHROMIC ACID.

By Yogoro Kato and Toru Murakami.

The curve of the cathodic potential against current density in the electrolysis of chromic acid, has several steps or breaks. The authors divide the cnrve into two parts. (1) The part for the cathodic potential lower than 0.8 volts, against normal hydrogen electrode; and (2) that for the lower potential. The first part is quite smooth and the chromium plating is generally carried out in this region. In the second part the phenomena is more complex and here are found the breaks or steps above mentioned. The authors proposed to explain this in the following way, taking the hydrogen overvoltage into account. Hydrogen overvoltage for chromium in chromic acid is fairly large. Consequently when chromium begins to be deposited on the cathode, the cathodic polarisation is suddenly raised, and so the volt-ampere curve shows a step. Thus the nature of the characteristic portion of the curve becomes clear. The characteristic hysteresis shown in the volt-ampere curve for descending current density using cathode other than chromium is also accounted for as being due to the chromium deposited on it.

It is generally observed that the reduction of chromium on platinum and carbon is not easy. The authors think that metals which are easily plated by chromium have in general a high hydrogen overvoltage. Gradual lowering of hydrogen overvoltage with the continuous passage of current was observed.

Sulphate ion was also observed to be a catalyser for electrolytic reduction of chromic acid, which lowers the cathodic polarisation. But when the solution contains chromium ion beside SO_4'' the cathodic polarisation becomes higher.

Obituary.

MR. R. W. MATTHEW.

We regret to learn from the Department of Overseas Trade of the death on November 8, after a very brief illness, of Mr. R. W. Matthew, C.M.G., Director of the Trades, Empire and Economic Division of the Department. Mr. Matthew, who was only forty-nine years of age, joined the staff of the Department of Overseas Trade in December, 1917, after a successful career at the Board of Trade, where he had served as private secretary to four successive Presidents, Mr. Sydney Buxton(Lord Buxton), Mr. John Burns, Mr. Runciman, and Sir Albert Stanley (Lord Ashfield).

His work at the Department of Overseas Trade will be well known to many of our readers, and especially to the Chambers of Commerce, with whom he was always in close touch.

DEMOCRITUS, B.C. 460-370.

Having recently referred to Democritus in these pages (see *Chemical News*, 1928, 137, 274) it may be of interest to give the famous lines attributed to this early philosopher, which are:—

" 1.—From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules.

" 2.—Nothing happens by chance. Every occurrence has its cause from which it follows of necessity.

" 3.—The only existing things are atoms and empty space; all else is mere opinion.

" 4.—The atoms are infinite in number and infinitely various in form; they strike together and the lateral motions and whirlings, which thus arise, are the beginnings of worlds.

" 5.—The varieties of all things depend upon the varieties of their atoms, in number, size and aggregacion.

" 6.—The soul consists of fine, smooth, round atoms like those of fire. These are the most mobile of all. They interpenetrate the whole body and in their motions the phenomena of life arise."

G. F. Rodwell, F.C.S., in 1872 wrote:—" The idea that all things are composed of minute indivisible particles or atoms, seems to have originated in India long before its introduction into the philosophies of Leucippus and Democritus. Kanáda, the founder of the Nyaya System of Hindu philosophy, taught that all material substances exist first as atoms, and afterwards

as aggregates of atoms. At the creation the atoms fell together to produce air, then fire; a greater condensation produced water, and the greatest earth. Democritus (460 B.C.) taught that all matter is composed of indivisible particles, which are impenetrable, and differ from each other in weight, form, size, but not in composition. The production of material forms is due to different arrangements of these atoms, which are actuated by necessity or fate (ἀναγχή). They are invisible by reason of their solidity, and unalterable. They are infinite in number, and various in form. They possess oblique motion in a vacuum; and when they fall together, by their collision and entanglement, they produce all things. Democritus asserted that there is a vacuum in nature, otherwise motion of the atoms would be impossible, because there would be no place to receive them."

Prof. D'Arcy W. Thompson, F.R.S., under the title LUCRETIUS, *Nature*, 1928, 121, 566, says :—

" Less than a twelvemonth ago I paid my last visit to Arrhenius. As we walked past the Museum hard by his house, and looked up at the great names inscribed upon its walls, Arrhenius said, ' Surely Democritus was the greatest of them all.' It was the mantle of Democritus which Epicurus wore, and it was at Epicurus's feet that Lucretius sat to learn the story of the atoms; but who it was that had told it to Democritus we do not know. Democritus was a rich man's son in a provincial town, about the time when Xerxes drew his broken fleet and army home from Salamis; he has left nothing of his very own, save a few hearsay fragments and broken sentences out of his many books. Yet at this day a great physicist looks on him with something like awe, and speaks of him with reverent admiration; for he was the father, so far as all our pedigrees can go, of the most fundamental postulate of all physical science.

" The shadows which surround the person of Democritus are but part and parcel of the mystery which hides the origin of the Greeks and the sources of their wisdom. Pythagoras, Thales, Heraclitus, and others besides Democritus are shadowy and all but legendary figures; we trace our science and learning back to them almost as the Japanese trace their empire to the sun and moon. But even Greek wisdom did not come straight from heaven; there were brave men before Agamemnon and wise men before Democritus. The world had rung with the clash of armies and the fall of ruined empires before the day of Greece began; time and again an old order passed away, giving place to new; but doubtless when almost everything was lost, a few seeds of ancient learning, Hittite, Chaldean, Cretan, Egyptian, and what not, fell upon good Greek soil and multiplied an hundredfold. Our ignorance of what did happen, and how and when, is the deepest puzzle and the greatest romance of history."

Even in modern writings by the greatest of our time we find the word *fate* invoked. It was Sir James Jeans who referred to the disintegration of uranium as a process in which *fate* knocked at the door of the atom, after a lapse of very many years, and forthwith it gave up a helium nucleus and stepped down to a lower position in the chemical series.

And going back to the sixth statement attributed to Democritus, it is only necessary to change the word *fire* into *electrons* to suggest a basis of life as I have attempted to show in a footnote in my article referred to at the outset.

My view is, however, that the ancient writings are only frames, so to speak, which give a pleasing setting to modern advances which form the truer picture. The mystery deepens, but the experimental steps are many, and it is these that are of real importance.

F. H. L.

GENERAL NOTES.

THE COMING COAL REVOLUTION.

Now that the scientific treatment of coal has again become a topic of first-rate importance, thanks largely to the prominence given to it in the discussions of the recent World Power Conference, the real facts relating to the progress of low temperature carbonisation are clearly emerging.

The first fact is that although there are said to be a large number of different methods, or processes, of distilling coal at relatively " low " temperatures (as distinct from high temperature distillation, by which the maximum amount of by-products is removed, leaving only the ordinary coke as the residuum) only a very few have passed the laboratory and intermediate stages and are capable of commercial application.

The second fact is that, for the first time in the history of low temperature experimentation, there has been a unanimous and unqualified admission by Government officials, and by fuel technicians of the most

conservative school, that one or two of such processes have reached the commercial stage.

The third fact, which will give the greatest satisfaction to those who feel that Britain, as the greatest coal producing country in the world should take the lead in scientific fuel developments, is that a leading authority on low temperature carbonisation who attended the Conference took the view that British processes are leading the world.

Thus Dr. F. S. Sinnatt :—

"There is a tendency for this country to be rather too modest but it is fair to say that in connection with the development of low temperature carbonisation Great Britain is in advance of other countries."

It is an open secret in the fuel world that certain foreign interests, convinced as they are that the hour of the fuel revolution is at hand, are straining every nerve to ensure that their processes should be exploited by such enterprising colliery companies, gas concerns and municipal authorities as are considering the manufacture of smokeless fuel by the low temperature method. It will be remembered that recently Mr. G. D. Hardie, a Labour member, drew the attention of the House of Commons to this subject, and protested against our official departments being drawn into encouraging foreign processes when British enterprise led the way.

THREE ENTERPRISES.

The country has been flooded with information concerning the alleged wonderful success of German processes. Yet, when the facts are considered, it will be found that Britain has secured a real fuel triumph.

(1) A great British gas company, in conjunction with the Fuel Research Board, is putting down a commercial low temperature plant in London. It is adopting a British process.

(2) Another great gas concern is rapidly completing plans for producing cheap smokeless fuel and using the gases produced in the process for enriching the domestic gas supply. It is employing a British process which has proved its practicability in 15 months non-stop production on a commercial scale.

(3) The Glasgow Corporation has built a *municipal smokeless fuel* plant on low temperature lines—another British process.

The Metropolitan Medical Officers, the West Riding Regional Smoke Abatement Committee, the Manchester and District Smoke Abatement Committee, and numerous individual Medical Officers and local administrators have visited Yorkshire where *coalite is being* produced at the rate of 1,500 tons a week under the British Parker system and have expressed unqualified approval of the fuel as a factor that will count in the future of smoke abatement.

The evidence is therefore clear that, apart from all considerations of the propriety of allowing the production from British coal of oil and pulverised low temperature fuels (perhaps the future fuels of the Navy) to pass under foreign domination, the British low temperature enterprise has established a prior claim on industrial and domestic users by reason of sheer merit and technical superiority.

MINING IN NOVA SCOTIA.

By A. H. A. ROBINSON.

(Canadian Department of Mines.)

Mining is one of the chief lines of industrial activity in Nova Scotia and coal is the chief mineral product; next to coal comes gypsum, then salt. Iron ore is no longer mined having been completely displaced in the local iron industry by ore from Newfoundland. The past few years, however, have seen a marked revival of interest in Nova Scotia gold mines.

Much the greater part of Nova Scotia's coal output comes from the Sydney coal field in Cape Breton island, which is not only the largest in the province, but the most highly-developed and productive in the Dominion. The recently completed No. 1B shaft of the Dominion Coal Company, sunk primarily for the winning of undersea coal, is one of the best examples on the North American continent of the application of modern devices and methods of permanent construction to the needs of the coal miner. It is estimated that the life of this shaft will be at least 125 years and possibly 200 years; and that before it is abandoned some 140,000,000 tons of coal will have been hoisted through it. Though the Sydney coal field is the most important in the province, there are also important productive fields in Cumberland and Pictou counties on the main land.

Gypsum was mined in Nova Scotia in 1829, but it is in recent years that the industry has had its most remarkable expansion. The present output of over 800,000 tons annually is more than three times that of all the rest of Canada. Gypsum deposits containing an excellent grade of material are widespread in the central and eastern parts of the province and are extensively

worked in a number of localities. The chief producing centre is in the vicinity of Windsor, in Hants County, though there is an increasingly large output from a number of quarries scattered over Cape Breton Island, and the Canada Cement Company have recently opened large quarries in Antigonish County, on the mainland. In spite of the large production very little gypsum—less than 2 per cent. of the output—is calcined in the province, nearly all of it being shipped to United States points.

Salt mining is the third most important and youngest mining industry in Nova Scotia. Commencing with small shipments in 1919 the value of the annual output is now well over $100,000. Malagash Salt Products, Ltd., at Malagash, Cumberland county, is the only producer. Parts of the Malagash salt beds are so pure that excellent commercial grades of salt can be obtained by simply crushing and screening the rock as it comes from the mine. During the present year the company has added an evaporator to its plant, by means of which the less pure portions of the beds also can be utilised and the finest grades of domestic salt added to its commercial products. An interesting feature of the Malagash salt beds is the presence of potassium salts, which may ultimately be found in sufficient quantity to make their recovery profitable.

Gold mining has had a distinct revival in Nova Scotia during the last few years, and operations are reported on a dozen or more old mines. Production ,however, is still limited to a few thousand ounces annually. There is a marked tendency towards the consolidation of properties with a view to more economical and systematic development.

Diatomaceous earth, a material extensively used as a heat insulator, for the purification of oils, etc., has for many years been extracted in a small way in Colchester county by the Oxford Tripoli Sales Company. This year a second company, Scotia Diatom Products, Ltd., has opened extensive deposits and started producing similar material near Little River in Digby County.

Zinc and lead do not yet appear in the list of Nova Scotia's mineral products, but are likely to be listed shortly. Since early in 1927 the British Metals Corporation of Canada, Ltd., have been developing a zinc-lead prospect at Stirling, Cape Breton, and now announce that sufficient ore has been put in sight to warrant the erection of a 200 or 250-ton flotation mill for its treatment. The shipping products will be zinc concentrates and lead concentrates. There is much activity in the investigation of known occurrences of copper, lead, zinc, and tungsten in various parts of the province, of tin at New Ross, and of auriferous antimony ore at West Gore in Hants County, and it is not unlikely that some of these prospects will in due course add to Nova Scotia's total mineral output.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, November 15 :

The Mode of Formation of Neumann Bands. (I)—The Mechanism of Twinning in the Body-Centred Cubic Lattice. (II)—The Evidence that the Bands are Twins. (III)—The Movement from which the Twinning Results. By S. W. J. SMITH, F.R.S., A. A. DEE, AND J. YOUNG.

(I) contains a discussion of atomic movements which could occur, under the influence of transient shearing stress, in a single crystal possessing a body-centred cubic lattice. Various ways in which a lamellar twin-structure could arise within the crystal are examined with the object of finding which of them is most likely to occur.

(II) contains a detailed proof that Neumann bands are twin lamellæ. The orientation of these lamellæ with respect to the matrix is determined quantitatively by means of etch-figures.

(III) contains an account of a method of determining the movement from which the twin structure results, by a study of the phenomena which accompany the crossing of one band by another. t is proved that this movement is of the kind shown to be most likely in (I).

An Investigation of Some Banded Structures in Metal. By C. F. ELAM. With an Appendix by G. I. TAYLOR, F.R.S. Communicated by G. I. Taylor, F.R.S.

Some metal crystals showing a banded structure similar to twins in minerals have been prepared and examined with a view to determining the crystallographic relationship of the bands. Twins of the spinel type were found in aluminium and silver. A structure of similar appearance produced by extending a crystal of aluminium was found to consist of bands whose plane of union was a crystal plane of form {113} in which the two parts were mirror images of one another. Prof. G. I. Taylor has shown

how such a structure can be derived from one crystal by means of deformation.

The Difference Between the Mechanical and Optical Lengths of a Steel End-Gauge. By F. H. ROLT AND H. BARRELL. Communicated by Sir Joseph Larmor, F.R.S.

The paper describes an investigation of the relation between mechanical, geometrical and optical lengths of end or block gauges constructed of steel. A knowledge of the difference between mechanical and optical lengths of such gauges is necessarp in order to derive mechanical lengths from optical interference methods of measurement, which entail reflection of light from the measuring faces of the gauges.

A set of block gauges is optically measured by an interference method. By comparing the sum of the optical lengths of the single gauges with the optical length of a wrung combination of the same gauges, the average difference between mechanical and optical length of a gauge may be derived. The results closely confirm those obtained by Pérard and Maudet at the Bureau International in so far as difference between geometrical and optical lengths (or the phase loss at reflection) is concerned, but they disagree with these observers' value of the difference between mechanical and optical lengths. It is shown that the new value is more consistent with previous work (*Roy. Soc. Proc.*, *A*, vol. 116, p. 401, 1927) than that obtained by Pérard and Maudet, since the latter leads to a negative value for the thickness of a wringing film.

The difference between mechanical and optical lengths may be calculated for all wave-lengths greater than 0.55μ, by the formula :—

$$(M-O)=p\lambda+t'$$

where $p = 0.27$, $t' = 0.005\mu$, and λ is in microns. The values given by Pérard and Maudet are $p = 0.25$ and $t' = -0.06\mu$. For light of wave-length $0.62\mu (M-O)$ has a value of 0.173μ or 6.8×10^{-6} inch.

Hyperfine Structure in the Arc Spectrum of Cæsium and Nuclear Rotation. By D. A. JACKSON. Communicated by F. A. Lindemann, F.R.S.

The spectrum was investigated with the object of finding whether any of its lines possessed hyperfine structure, resulting from a nuclear magnetic moment, due to a quantised nuclear spin. Lines belonging to the principal series should, owing to greater degree of penetration of electron in the (1s or 6_1) orbit, and correspondingly greater interaction, show the greatest effect. Lines of the principal series are very easily broadened if the vapour pressure of the metal becomes high, so that great care was taken to obtain the spectrum at a sufficiently low temperature.

The most satisfactory method of excitation was found to be the application by means of external electrodes of a very high-frequency alternating current to a tube filled with helium at about 2 mm. pressure containing a small quantity of cæsium. The tube required slight heating to bring out the cæsium lines; without this the helium spectrum was very much stronger than the metallic spectrum. At very low vapour pressures the discharge was blue in colour. Under these conditions lines of the principal series showed no broadening greater than that due to thermal agitation, but at a slightly higher temperature the colour of the discharge became purple and the lines broadened.

Lines belonging to principal series were found to be very close doublets with nearly constant frequency differences. A theory is worked out which explains the origin of these doublets, assuming a nuclear spin of one half quantum; by correlating difference in separation of hyperfine structure doublets in $1s-m^2p_{3/2}$ lines and $1s-m^2p_{1/2}$ lines, it is shown that a ratio of magnetic to mechanical moment of nucleus about twice as great as corresponding ratio for electron would account for observed frequency differences.

Papers read in title only :—

A Symmetrical Treatment of the Wave Equation. By A. S. EDDINGTON, F.R.S.

The complete set of matrices of the type used in Dirac's linear wave equation consists of 15 members together with the unit matrix. It is shown that these can be arranged in six " perpendicular " sets of five, each member appearing in two sets. The condition that the wave equation shall satisfy the principle of relativity requires that the matrices of its five coefficients shall form a perpendicular set. It is arbitrary which set shall be used and which order of terms of the set shall be adopted. Dirac's form represents one special choice of matrices. It is shown that much of the general theory (including deduction of second-order equation, angular momentum of electron, conservation of charge-current vector) is obtained more simply and symmetrically without introducing particular matrices, but employing only commutative and other general properties of a perpendicular set.

An apparently more fundamental way of reaching the wave equation is by taking as the condition to be satisfied not observed

relativity transformations of space-time, but observed invariance of proper-mass of electron. The wave equation satisfying this is written down, and relativity transformations of physical magnitudes occurring as coefficients can then be deduced. But this new wave equation contains nine matrices and corresponds to two electrons with opposite spin. This duplexity phenomenon appears in the most inevitable way and is seen to be inherent in the scheme of perpendicular sets of matrices, where sets of four perpendicular matrices are coupled in pairs by a ninth matrix perpendicular to both.

The Wave Pattern of a Doublet in a Stream. By T. H. Havelock, F.R.S.

A study of the surface disturbance due to a doublet and the dependence of its character upon the relation of the velocity of the stream to the depth of the doublet. The integrals are evaluated numerically in certain cases and graphs of the surface elevation are given.

A Mathematical Discussion on the Structure of Wood in Relation to its Elastic Properties. By A. T. Price. Communicated by S. Chapman, F.R.S.

A theory of the elasticity of wood, which takes into account its anatomical structure, is partly developed. It is shown that the observed elastic anisotrophy of wood can be explained in detail by the fact that wood is built up of long hollow cylinders, of which the majority are arranged parallel to the grain and the remainder are grouped into bundles extending radially. The annual layers appear to have little influence on this elastic anisotropy. When the spring and summer-woods differ appreciably, complex internal stress-systems are introduced, and usually (not invariably) the stronger portions of the material take up most of the stress. The theory suggests, however, that gross deformations of a good specimen of wood, even when annual layers are well marked, may be calculated as if homogeneous, the " apparent " elastic moduli obtained on this assumption being invariants for different sized specimens and different methods of testing.

The low values of so-called moduli of rigidity, and various phenoment observed in tests which involve longitudinal shearing, show that non-elastic slipping of some kind takes place in wood at stresses much lower than those usually associated with elastic failure. This possibly occurs between thick-walled cells and between medullary rays and adjacent cells, and also as gross slip in the layers of weak spring-wood tissue, and will have important consequences on distribution of stress in various deformations (as in bending of beams).

The Special Distribution of Photo-Electrons Produced by X-rays. By E. J. Williams, J. M. Nuttall and H. S. Barlow. Communicated by W. L. Bragg, F.R.S.

The paper deals with an investigation on the initial directions of emission of photoelectrons produced by homogeneous X-rays. The two well-known features of " longitudinal ' distribution generally observed by investigators are (1) emission of photoelectrons over wide range of angles (" dispersion ") and (2) much greater emission of photoelectrons in forward direction of X-rays than in backward direction, (longitudinal asymmetry). According to Auger and Perrin the probability of photoelectron emission in any given direction in proportional to mean-square of component of electric force in that direction, the $\cos^2 \theta$ law, whilst longitudinal asymmetry is usually attributed to momentum of incident X-ray quantum communicated to ejected photoelectron. Survey of previous investigations reveals discordant results, discussed in earlier part of paper. Precautions taken to eliminate errors in experiments are described.

Results of authors' own investigations given refer to the photo-electron emission from oxygen and nitrogen due to absorption of X-rays of wave-lengths 0.54, 0.61 and 0.71 A. respectively. The Wilson cloud-expansion method is employed for photographing the tracks. The results show:—(1) spread or dispersion of the photoelectrons may be satisfactorily represented by the $\cos^2 \theta$ law, and (2) longitudinal asymmetry, if distribution corresponds to an average forward momentum of photoelectrons, abont 40 per cent. greater than that of an absorbed quantum. This last observation, based on examination of nearly 1,800 tracks, is the most important result.

Structure of the Violet Bands of Silicon Nitride. By F. A. Jenkins and H. de Laszlo. Communicated by Sir Ernest Rutherford, P.R.S.

The violet SiN band spectrum excited by active nitrogen has been photographed with high dispersion, and measurements of structure lines of the 10 strongest bands tabulated. Each band has doublet P and doublet R branch, with one missing line, in complete accord with theoretical predictions for a band system of $^2S \rightarrow {}^2S$ type. Combination relations between P and R lines are applied to find term-differences, from which rotational constants are evalu-

ated. Band-origins are determined, and an equation derived for them giving vibrational energy in initial and final states. Isotope effect is well-marked for $Si^{28}N$, $Si^{29}N$ and $Si^{30}N$, and in three hands of strongest sequence quantitative evidence is adduced supporting quantum-mechanics expression for vibrational energy.

Ground Terms in the Spectrum of Nickel II and Proposed Standard Wave-length in the Schumann Region. By A. C. MENZIES. Communicated by R. Whiddington, F.R.S.

A method of obtaining spectrograms with exposures of order of 1/100 second in the Schumann region (by fusing wires) has been devised as already reported to this Society. It was found that the method was particularly well suited to investigation of ground-terms, and it is consequently here applied to elucidate those of Nickel II, most of whose other terms have been found by Shenstone.

Using the fuse horizontally in the vacuum grating spectrograph and very near the slit, there is a tendency to form "long and short lines," in spite of astimgatic action of grating. Many lines, obviously connected on account of length and strength, were found on analysis to belong to hitherto unknown ground-terms, $^2D_3$ and $^2D_2$, of Ni II. Wave-lengths of some lines between 1965 and 1858 A.U. were also measured with a quartz spectroscope, using as sources arc in and and fuse in air. This afforded a check upon vacuum grating measurements.

Since the combining middle terms are known with accuracy, determination of values of $^2D_3$ and $^2D_2$ allows calculation of conveniently spaced lines as standards in Schumann region. The lines extend from 1317 to 1940 A.U.

Lines involving ground-terms of Cu II and Ag II, as measured by the author, are given for comparison with measurements made by Lang and by White respectively. Spectrograms obtained by this method of Ni, Cu and Ag are given.

On the Principle of Least Action in Wave-Mechanics. By J. M. WHITTAKER. Communicated by E. T. Whittaker, F.R.S.

The connection between Dirac's wave equations and the equations suggested by the writer in a recent paper is discussed. It is shown that the theory of the hydrogen atom, worked out by Darwin and Schlapp on the basis of Dirac's equations, can also be based on the writer's equations. The latter are covariant, can be written in tensor form, and can be deduced from a "Principle of Least Action."

The same variational principle supplies electromagnetic and gravitational equations needed to complete the scheme. These differ from the equations of Maxwell and Einstein, having "wave" terms instead of "partide" terms for electric current vector and material energy tensor. Finally, it is shown that four identical relations exist between the equations.

The Spectrum of Doubly Ionised Fluorine (FIII). By H. DINGLE. Communicated by A. Fowler, F.R.S.

The spectrum of doubly ionised fluorine, obtained by passing strong discharges through silicon tetrafluoride, has been isolated, and 314 lines, extending from λ 3267 to λ 2207, measured and tabulated.

The spectrum has been partially analysed into quartet and doublet systems of terms, which are correlated with the terms to be expected on the Heinsberg-Hund theory, and 82 lines are slassified.

Comparison of the spectrum with that of singly ionised oxygen shows close correrspondence, with a few exceptions discussed.

ROYAL AGRICULTURAL SOCIETY.

At the council meeting on November 7, a number of reports were presented including that of the Chemical Committee.

Mr. Brocklehurst (Chairman), reported that the list of samples analysed for members the Consulting Chemist during the months of August, September and October had been submitted to the Committee.

The Consulting Chemist had presented the following report :—

Castor-oil Bean in Compound Cake.—A member of the Society sent me towards the end of July for analysis a sample of compound cubes which he had been feeding to his cows for the past two months. Two cows then, however, were taken ill, and, according to the veterinary surgeon's statement, showed signs of poisoning.

On examination of the cake I found it to contain castor-oil bean in some quantity. When the use of the cubes was discontinued the cows recovered.

This instance shows how variable may be the distribution of a poisonous material like castor-oil bean in a delivery of cake. Doubtless the cake that had been consumed up to the time the trouble began contained either no castor-oil bean or but a little, and then, in course of feeding, a bag or so which contained more castor oil was met with and caused the illness reported.

THE CHEMICAL SOCIETY.

Thursday, November 15.

The Densities of Butyric Acid-Water Mixtures. By J. GRINDLEY AND C. R. BURY.

It is argued that micelle formation must lead to abrupt changes in the slope of physical property-composition curves. The densities of butyric acid-water mixtures at 0°, 12°, 18°, 25°, and 35° have been measured and partial specific volumes calculated. The results obtained support the contention of Jones and Bury that micelle formation occurs in these solutions.

Studies of Valency. Part XII. Isomeric Derivatives of Diethyl Telluride. By F. L. GILBERT AND T. M. LOWRY.

α-Diethyltelluronium di-iodide yields an α-base, which is converted into an isomeric β-base when the aqueous solntion is evaporated to dryness in a vacuum. From the β-base a series of β-salts can be prepared. The two series of salts differ in their behaviour towards alkali, since the α-iodide gives a colourless monoxyiodide, whereas the β-iodide gives a triethyltelluronium salt; a tetra-iodide could only be prepared from the α-base. The β-base is stronger than the α-base, and gives an inflected potentiometric curve, as in the methyl series.

Studies of Valency. Part XIII. Further Experiments on the Molecular Structure and Configuration of the Quadrivalent Derivatives of Tellurium. By T. M. LOWRY AND F. L. GILBERT.

The structure and configuration of the quadrivalent derivatives of tellurium are discussed in relation to the fact that the isomerism of the telluronium bases disappears when they are reduced to tellurides or oxidised to tellurones.

The Effect of Intensive Drying in Certain Physical Properties of Benzene. By H. V. A. BRISCOE, J. B. PEEL, AND P. L. ROBINSON.

This paper describes various pieces of apparatus in which benzene has been dried for periods up to 16 months, special precautions having been taken in the filling of these to ensure the addition of phosphoric oxide without contamination by atmospheric moisture. During the drying the densities and surface tensions of the liquids as a whole and in various fractions have been determined. The general conclusion reashed is that there is no material change in either of these physical properties in the time specified.

Passivity of Metals. Part II. The Breakdown of the Protective Film and the Origin of Corrosion Currents. By U. R. EVANS.

The corrosion which occurs on iron, steel, zinc, and aluminium subjected under anærobic conditions to anodic treatment by means of an externally applied *E.M.F.* commences at a limited number of points; the phenomena can be explained satisfactorily only by assuming that the sites of attack represent weak places in the invisible oxide film. In the corrosion by a salt solution in presence of oxygen, but without an externally applied current, attack sets in first at just the same places, namely, where the metal has been sharply bent or cut, or where rolling or casting defects occur in the surface; evidently the cause of localisation is here the same. Sometimes (as with zinc) corrosion starts at the site of pre-existing cavities. Internal stresses determine the sites of attack by keeping the film in a state of weakness. Differential aeration currents are due to differences of potential existing between (1) the places where the film is kept in good repair by a supply of oxygen, and (2) those where it is not kept in repair; *E.M.F.* approaching 0.5 volt due to this cause have been registered, but the *E.M.F.* diminishes when a corrosion-current actually flows. The extension of a film breakdown or its repair can be followed by potential changes.

Mechanism of Corrosion. By U. R. EVANS.

The corrosion of zinc, aluminium, iron, steel, and copper in salt solutions commences at a limited number of "weak points" in the invisible oxide film; in the case of zinc, iron, and steel it spreads out rapidly until most of the immersed surface is affected. The weak points are mainly situated along the bottom or cut edges of specimens, but are sometimes found at surface defects in the centre, or under special circumstances at the water line. Four types of final corrosion products are obtained according to the manner in which anodic and cathodic products come together.

Quantitative experiments show that, under conditions of differential aeration, electrolytic iron is attacked nearly as fast as steel, whilst potassium sulphate and potassium chloride cause similar rates of total corrosion, notwithstanding that the shapes of the corroded areas are quite different; magnesium sulphate causes slower attack. Zinc is attacked more quickly than iron, and aluminium much more slowly. Oxygen produces quicker attack than air, but it is restricted to a smaller area; doubling the breadth of half-immersed specimens nearly doubles the corrosion, but

increase of the length of the specimens has much less effect on the rate of attack. An interpretation of these results is given.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Drilling and Production Methods in the Greater Seminole Field, Oklahoma, U.S.A. By G. HESELDEN, M.Sc., Assoc.M.Inst.C.E., A.M.Inst.P.T.

The Greater Seminole Field is made up of five separate pools, namely, the Searight, Seminole City, Bowlegs, and Little River pools in Seminole County and the Earlsboro pool in both Seminole and Pottawatomie Counties, Oklahoma.

The field has produced some 200,000,000 barrels of oil up to the end of June, 1928.

The gravity of the oil varies between 37° and 42° Baumé, the average being about 40°.

The main producing horizon is the Wilcox Sand, which is found at a depth of from about 4,000 ft. to 4,300 ft. The Wilcox Sand is a fairly uniform fine grained sandstone—Ordovician in age.

A few of the wells produce from the Hunton Lime which is found at a depth of from 3,800 ft., to 4,200 ft. The Hunton Lime is not found in all wells, it is more prominent in the Searight pool than in the others. The Hunton Lime is a dark grey limestone which is found above the Wilcox Sand, it is of Siluro-Devonian age. The oil in the Hunton Formation is of a somewhat lower gravity than the oil produced from the Wilcox Sand.

The total depth of the wells ranges from 4,000 ft. to 4.400 ft. depending on the location.

Nearly all the wells have been drilled down to 3,700 or 3,800 ft. with rotary tools, at which point a string of 8¼ in. casing is set and cemented. No water sands are encountered below this depth until the pay sand has been passed.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on November 6, Dr. G. T. Prior, President, in the chair :—

The So-Called " Thermokalite " and the Existence of Sodium Bicarbonate as a Mineral. By F. A. BANNISTER.

The composition of a large collection of saline incrustations collected by Dr. Johnston-Lavis about 1889, has been investigated. He labelled them " thermokalite " but they are found to be a mixture of trona, thermonatrite, thenardite, and free sodium bicarbonate; no potassium salts are present. The name nahcolite is proposed for naturally occurring sodium bicarbonate. These incrustations were found lining the walls of a cuniculus near the Stufe de Nerone, Baia, Naples, Italy; their mode of occurrence is discussed from a physical-chemical point of view.

The Piezo-electric Effect of Diamond. By DR. W. A. WOOSTER.

The effect has been investigated by a delicate method using magnetic attraction to apply pressure to the diamond. The result shows that the effect, if it exists, is less than 1/200th of the effect observed in quartz cut perpendicular to the electric axis.

MR. J. D. BERNAL and NORA MARTIN showed X-ray photographs of the arkansite variety of brookite indicating that the space-group is Q_h^{15}. An explanation was offered of how A. Schröder's observations did not lead to this result.

MR. F. N. ASHCROFT exhibited specimens of minerals collected recently in Switzerland, together with photographs of the localities represented.

THE OPTICAL SOCIETY.

At the meeting held at the Imperial College of Science and Technology, South Kensington, on Thursday, November 8, the following papers were read and discussed :

On Systems of Plane Reflecting Surfaces. By T. SMITH, M.A., F.Inst.P.

An algebraic method is evolved of finding the co-ordinates of the image of any point and of the direction of the emergent portion of any given incident ray after reflection at any number of plane reflecting surfaces. Systems of reflectors are classified according to the nature of the self-conjugate region of the field. A method of designing a system having any assigned properties is described. Suitable criteria are given to determine whether with a prismatic system the whole is non-dispersive, and whether total internal reflection takes place at any given surface; also the boundary conditions at each surface are found. The calculations are simple and free from any ambiguity of sign.

Reflecting Systems for Image Inversion. By T. SMITH, M.A., F.Inst.P.

The method of investigating systems of plane reflectors described in another paper has been applied to determine how many optical surfaces are necessary in an inverting prism. Four surfaces involve oblique refraction into the prism whatever the number and order of the reflections. With five

surfaces one form is possible with four reflections. All possible arrangements with six reflections at five surfaces are considered, and the application of the method to prisms with a greater number of reflections is illustrated.

The Relations Between Field Illumination and the Optimum Visual Field for Observational Instruments. By PROFESSOR L. C. MARTIN, D.I.C., A.R.C.S., D.Sc., AND T. C. RICHARDS, D.I.C., A.R.C.S., B.Sc.

Experiments based on the application of the results of recent studies on "spatial induction" in vision to determine the conditions governing the optimum size of visual field under certain conditions are described. The results have a bearing on recent efforts greatly to enlarge the fields of view of binoculars, indicating that small fields are better under certain conditions.

SOCIETY OF PUBLIC ANALYSTS.

An Ordinary Meeting of the Society was held in the Chemical Society's Rooms, Burlington House, on November 7, the President, Mr. Edward Hinks, in the chair.

Certificates were read for the first time in favour of Edwin Herbert Bunce, A.I.C.; Frederick O'Brien, M.Sc., F.I.C.; William Macro Seaber, B.Sc., F.I.C.; John Graham Sherratt, B.Sc., F.I.C.

Certificates were read for the second time in favour of Charles Wesley Bayley, Harry Brindle, B.Sc., A.I.C.; William George Burgess; George Leonard Clothier; Hector Ingram Downes, M.Sc., A.I.C.; Alec Walter Greenhill, M.Sc., A.R.C.Sc., A.I.C.; Donald R. Hayward, B.Sc.; B. L. Khuller, M.Sc., A.I.C.; James Donald Kidd, B.A., M.Sc., A.I.C.; Herbert Drake Law, D.Sc., F.I.C.; Sidney John Saint, B.Sc., A.I.C.

The following were elected Members of the Society: Bhagwat Prasad Bhargava, B.Sc.; Cyril Ernest Gill; and Thomas Percy Hilditch, D.Sc., F.I.C.

The following papers were read and discussed :—

The Determination of Small Quantities of Antimony in the Form of Stibine. By JULIUS GRANT, M.Sc., A.I.C.

An improved form of apparatus of the electrolytic Marsh type is described, by the use of which antimony is completely and rapidly removed from its solution in 0.5*N* hydrochloric acid, in the form of stibine, by means of a swift stream of hydrogen bubbles impinging on the point of an inverted cone lead cathode. This ensures removal of the gas from the electrolytic cell before it is decomposed. The antimony in the deposit may be determined by comparison with standard stains or, with sufficient accuracy for most purposes, by a colorimetric method. Small quantities of antimony (10 to 0.001 mgrm.) have thus been determined in alloys, ores, rubber, etc., in the presence of other metals.

The Determination of Unsaponifiable Matter in Oils and Fats. By E. LESTER SMITH, M.Sc., A.I.C.

It is shown that there are sources of error in all the methods previously described. In most of these the extraction of unsaponifiable matter is incomplete (80 to 98 per cent.), and hydrolysis of dissolved soap while washing the ethereal extract may result in fatty acid being weighed with the unsaponifiable matter. Two methods in which these errors are avoided are described, the first of which gives results accurate to within 1 per cent. of the amount of unsaponifiable matter present, whilst the second method, which is less tedious, gives results which, though a little less accurate, are more trustworthy than those of any previous method.

The Composition of Irish Butter. By PAUL ARUP, M.Sc., F.I.C.

Three quantities of butter fat were separated by chilling, so as to obtain a fraction liquid at 10°C. as the lower limit and one crystallising at 37° C. as the upper extreme. The Reichert-Meissl, Kirschner, Polenske and iodine values of the different fractions of glyccrides were determined. The figures obtained did not indicate any marked tendency for the volatile acids to be associated with oleic groups in preference to the stearic and palmitic groups, but on the whole support the view that the acid groups are impartially distributed among the different glycerides.

The Volumetric Determination of Mercury. By H. B. DUNNICLIFF, M.A., Sc.D., F.I.C., AND H. D. SURI, M.Sc.

The method is based on the reduction of mercuric chloride solution by means of stannous chloride in presence of sodium tartrate in an atmosphere of carbon dioxide. The supernatant liquid is filtered from the separated mercury through a special filter into a burette, and the excess of stannous chloride is titrated against ferric alum solution or standard iodine solution.

NOTICES OF BOOKS.

Studies in the History of Mediæval Science. By CHARLES HOMER HASKINS. Second Edition. Pp. xx + 411. London: Humphrey Milford, Oxford University Press, Warwick Square, E.C.4. 1928. Price 28s.

Prof. Haskins and others have been able to show that the Middle Ages were less dark and less static as regards science than has generally been admitted. The twelfth century, with which the present volume is especially concerned, was an age of continued enquiry into the secrets of nature. At this time, too, Arabic texts found their way into the west and the most important channel by which new learning from the Orient reached our civilisation was Spain, although it was not the only route by which Arabian science came to be better known. The science of mediæval Spain was, however, not purely Arabian for the conquering Mohammedans had assimilated the cultures of the Byzantine empire, Egypt, Syria and other parts.

In the present volume Prof. Haskins is concerned mainly with the work of translators from the Arabic in Spain, with Adelard of Bath, Hermann of Carinthia, the introduction of Arabian science into England and with translations from the Greek. He has also devoted some attention to the state of science in Sicily in the twelfth and thirteenth centuries and to the share of the Norman emperor, Frederick II, in patronising the early workers in astronomy and natural history.

In the chapter on Adelard of Bath, it is pointed out that whilst his works and translations are well known to scholars, little enough is known about him personally. He was born at Bath and was English, but at an early age went to the continent, where most of his work was carried out. Hermann of Carinthia, also known as "the Slav," contributed considerably to twelfth century mathematics and philosophy as well as to astronomy and his translation of Ptolemy's *Planisphere* constitutes the sole intermediary through which this work has survived to modern times.

Specialists in the history of science will be grateful to the author for his compilations and the extensive bibliographical references which considerably enhance the value of this important contribution to the mediæval contributions to scientific knowledge.

J. G. F. DRUCE.

Anleitung zur chemischen Gesteinanalyse. By PROF. DR. J. JAKOB. Pp. viii + 81. Berlin: Gebruder Borntraeger, Schoneberger Ufer, W 35. 1928. Price, bound, 7 marks.

This compact volume on the chemical analysis of rocks by Prof. Jakob will be welcomed by analytical chemists and others as there is considerable need for a work of this kind. This need is perhaps greatest among those who are not specialists in this particular branch but who incidentally require to conduct rock analyses and thus will be glad of a treatise of this kind for reference.

The methods of estimating silica, alumina, ferric oxide, titania, phosphates, alkali, alkaline earth and other metals, halogens, etc., under different conditions are described.

The book is really vol. 15 of a series, *Sammlung naturwissenschaftlicher Praktika*, published by Gebr. Borntraeger.

Notions Fondamentales de Chimie Organique. Par PROF. CHARLES MOUREU. New edition. Pp. x + 657. Paris: Gautier Villars. 1928.

Prof. Moureu's *Notions Fondamentales* is the great standard French textbook on Organic Chemistry and it is therefore not surprising to find that a new edition (the sixth) has appeared. This has entailed some revision and considerable extension in certain chapters. Thus, much new matter has been included in the sections dealing with colouring matters, explosives and compounds of therapeutic importance.

The plan of the book is to deal first with the general principles of organic chemistry including such matters as the methods for determining composition and constitution of organic substances. The many physico-chemical aspects are described together with such phenomena as the existence of homologous series, isomerism, stereochemistry, etc.

The first descriptive chapter deals with all the series of hydrocarbons for the subject is not divided to aliphatic and aromatic divisions. Chapter III deals with the compounds, containing oxygen, beginning with the "mono-hydric" alcohols and concluding with aromatic acids. In Chapter IV the numerous series of nitrogen-containing compounds are described.

There is a brief chapter on the organo-metallic compounds but these receive inadequate mention for even Grignard's reagents are dismissed in a few words.

Chapter VI is concerned with the heterocyclic bodies whilst subsequent chapters deal more with the applications and extensions of organic syntheses in the preparation of colouring matters, perfumes, substances of distinctive taste, medicaments and explosives.

In the brief chapter on the substances of distinctive taste an attempt has been made to correlate taste with chemical constitution. The bodies fall into four groups showing sweet, bitter, sour and saline tastes respectively. Thus the alpha-amino-acids are sweet, whilst the polyo-nitro-derivatives are bitter. It cannot, however, be claimed that studies in this direction have gone very far.

The volume can be recommended to students and others for exercise in the reading of French scientific literature and for its presentation of the subject.

J. G. F. Druce.

Messrs. Babcock and Wilcox have issued a booklet dealing with their low temperature coal distillation process (No. 919). This booklet will be sent to anyone interested on request.

Colloid Symposium Monograph. Edited by Prof. Harry B. Weiser. Pp. 346. New York : Chemical Catalog Co., 1928. Price $6.50.

This Monograph is a valuable symposium of the papers presented at the discussion on Colloid Chemistry at Toronto in June last. These papers, 25 in number, cover the whole of the subject and an adequate survey of them all is impossible. A list is therefore given of the contributions and contributors : Living Matter, Sir William B. Hardy; Electrical Relations at Surfaces, Spreading of Liquids, Thickness of Surface Films and the Drop Weight and Ring Methods for the Determination of Surface Tension, William D. Harkins; Surface Conductance, David R. Briggs; Effect of Adsorbed Water on Electrical Conductivity of Powders, F. B. Kendrick and F. J. Giffen; Activity and Adsorption of p-Toluidine in the Surface of its Aqueous Solution, J. W. McBain, W. K. Wynne-Jones and F. H. Pollard; Adsorption of Sodium Oleate at the Air-Water Interface, M. E. Laing, J. W. McBain and E. W. Harrison; Adsorption of Methylene Blue by Lead Sulphate, Wilder D. Bancroft and C. E. Barnett; Structure of Softwoods, Alfred J. Stamm, Fractionation of Diph theria Antitoxic Plasmas, P. J. Maloney and Edith M. Taylor; Cataphoresis of Blood Cells and Inert Particles in Sols and Gels, Harold A. Abramson; Methods of Studying the Surfaces of Living Cells, Stuart Mudd; Balduin Lucké, Morton McCutcheon and Max Strumia; The Role of Hæmoglobin in the Blood, A. Baird Hastings; Emulsification in Peptic Synthesis of Protein, H. Westeneys and H. Borsook; Emulsions, John C. Krantz and Neil E. Gordon; New Microscopic Methods in Vulcanisation, E. A. Hauser, H. Miedel and M. Hunemorder; Rubber Dispersions, H. L. Trumbull; Organophyllic Colloids, G. S. Whitby, J. G. McNally, and W. Gally; Gelatin Systems, J. R. Fanselow; Gel Structure and Smokeless Powder Manufacture, Fred Olsen; Grain Growth in Silver Halide Precipitates, S. E. Sheppard and R. H. Lambert; Uniform Distribution of Catalysts in Porous Solids, H. N. Holmes and R. C. Williams; The Ultracentrifuge, J. B. Nichols; Hydration Changes, H. A. Neville and H. C. Jones; Adsorption of Ions and Physical Characteristics of Precipitates, H. B. Weiser and G. E. Cunningham.

Inorganic Quantitative Analysis. By Prof. Harold A. Fales. Pp. xii + 493. London : G. Bell and Sons. 1928. Price 12s. 6d.

Prof. Fales' system of quantitative chemical analysis possesses many novel features. It introduces the principles of physical chemistry whenever possible and stress is laid upon technique and attention to details. But the dominant feature of the volume is the complete abandonment of the usual division into gravimetric and volumetric methods. Instead the principles of the subject are introduced in the following order (1) Precision, (2) weighing, (3) volume measurement, (4) neutralisation, (5) solubility product, (6) oxidation-reduction, and (7) gas analysis.

The exercises are chosen to fit in with both elementary and advanced work and standard processes have generally been followed. The author also gives many references to original communications and it is surprising how much of the fundamental analytical work of last century was first published in the *Chemical News.*

The numerous examples worked out at the end of each chapter should assist the student to understand the methods without difficulty.

Messrs. Ernest Benn have issued a catalogue of their scientific and technical publications. Chemists and others engaged in industry do not read enough, partly, at least, because they do not know of the existence of books which might help them,

and perusal of publishers' catalogues and the guidance of our book reviews, should asssist readers in choosing textbooks and treatises.

BUSINESS TOUR TO SOUTH AFRICA.

The Rt. Hon. L. S. Amery, in the course of a letter to the British National Union, 237-8 Moorgate Station Chambers, Loudon, E.C.2., commending the objects of the forthcoming tour of South Africa, says that "the tour will afford a splendid opportunity for giving business people in the country a chance of obtaining first-hand knowledge of the South African and Rhodesian markets and not only of travelling in company with those who have somewhat similar interests but of meeting a large number of prominent and interesting South Africans in a way which it might not be possible for them to do if their visit were made as individuals rather than as members of a party for which ample provision in the way of sight-seeing etc., has been organised.

The tour which commences on the 15 February, will afford British industrialists exceptional facilities to investigate conditions in a market which is increasingly becoming the object of special attack by American and Continental manufacturers.

Forthcoming Events.

ROYAL INSTITUTION.

Tuesday, November 27, at 5.15 p.m.—"Diamonds." By Sir William Bragg, F.R.S.

Thursday, November 29, at 5,15 p.m.—"The Mechanism of the Nerves." By Dr. E. D. Adrian, F.R.S.

THE BRITISH SCIENCE GUILD.

"The Culture Value of Natural History" is the title of the fourth annual Norman Lockyer Lecture to be given under the auspices of the British Science Guild by Professor J. Arthur Thomson, LL.D (Regius Professor of Natural History, University of Aberdeen), on Wednesday, 28 November, at 4.30 p.m., in the Goldsmiths' Hall, Foster Lane, E.C.2 (by permission of the Goldsmiths' Company). A few tickets for the Lecture are still available and are obtainable on application to the Secretary, British Science Guild, 6, John Street, Adelphi London. W.C.2.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

32,417.—Chemical Works, formerly Sandoz.—Preparation of compounds of C c-disubstituted barbituric acids, etc.

32,363.—Geigy Akt.-Ges., J. R.—Azo dyestuffs. November 6th.

32,810.—Geigy, Akt.-Ges, J. R.—Manufacture of acid dyestuffs.

32,319.—Kunstharzfabrik Dr. F. Pollak Ges.—Manufacture of condensation products.

32,612.—Kali-Chemie Akt.-Ges.—Producduction of calcined phosphates. November 23rd.

Specifications Published.

273,711.—Leschik, Dr. G.—Generation of oxygen from washing and bleaching agents containing persalts.

274,128.—I. G. Farbenindustrie Akt.-Ges. —Manufactures of azo dyestuffs.

299,743.—Carpmael, A. (I. G. Farbenindustrie Akt.-Ges.). — Dyeing by means of leuco ester compounds of dyestuffs of the indigo series and other vat dyestuffs.

299,909.—Carpmael, A. (I. G. Farbenindustrie Akt.-Ges.).—Process for the manufacture of sulphur dyestuffs.

299,934.—Robson, S.—Manufacture of sulphate of ammonia from gas-works liquor or the like.

Abstract Published.

297,366.—Dye intermediates.—Anderson, I. B., Thomson, R. F., Thomas, J., and Scottish Dyes, Ltd., Earl's Road, Grangemouth.

Pyrazoteanthrones are prepared by condensation of α-halogenanthraquinones with hydrazine or its salts in the presence of an oxide hydroxide or carbonate of an alkali or alkaline-earth metal or an alkali salt of a weak volatile organis acid; the reagents may be employed in a dry state or in the presence of limited amounts of water; the process is effected at high temperatures and under pressure or not. Quicklime, calcium hydroxide, a paste of lime and water, sodium carbonate, calcium carbonate, sodium acetate, barium oxide, or strontium oxide, or

mixtures thereof, are specified as alkaline reagents. When alkali salts of organic acids are used, the liberated organic acid may be allowed to escape or many be fixed by addition of a base. Examples are given of the preparation of pyrazoleanthrone and 2-methylpyrazoleanthrone from 1-chloranthraquinone and 1-chlor2-methylanthraquinone respectively.

Anthraquinone- -hydrazines are obtained as intermediate products in the above process and may be isolated when a reduced quantity of alkaline-earth oxide is employed; an example is given of the preparation of 1-hydrazinoanthraquinoue.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

YESTALT.

493,174.—Chemical substances prepared for use in medicine and pharmacy.—The English Grains Company, Ltd., Shobnall Road, Burton-on-Trent. November 7th.

EVIUNIS.

489,140.—Chemical substances prepared for use in medicine and pharmacy.—Cristallo Aktiengesellschaft, Thusis, Switzerland. November 7th.

MOX.

495,045.—Thermite, being a chemical substance for use in manufacture.—Merx, Limited, 36, St. Andrew's Hill, London, E.C.4. November 7th.

BIG BEN.

495,835.—All goods in class 1 which includes chemical substances prepared for use in medicine and pharmacy.—National Safety Services, Limited, 69, Wrawby Street, Brigg, Lincolnshire. November 14th.

PENTRONE.

493,486. A chemical eomposition in liquid form for use in the wetting out of textile fibres. — Glover Brothers (Leeds) Limited, Wortley Low Mills, Whitehall Road, Leeds, Yorkshire. November 7th.

SEDONAN BRAND.

490,803.—Chemical substauces prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. November 14th.

OLPHENO.

495,926.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Stotherts, Ltd, Albion Works, North Road, Atherton, Lancashire. November 14th.

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THE COLLINSICS OF MINERALS. VII.

Twenty-three Discoveries Which Led to Their Discovery.

By Hawksworth Collins, B.A. (Camb.).

All these discoveries were obtained by means of the Higher Research Work, which consists of correct mathematical reasoning upon (*i.e.*, investigation of the *truths which underlie*) all Experimental Research Data.

(1) The Atomic Weights are Whole Numbers.—This mathematical fact, discovered in 1901, constitutes the certainty upon which all the following discoveries were based. It has nothing whatever to do with Prout's guess. A treatise on the Constitution and Structure of the Chemical Elements, which was sent in 1906 to several leading British scientists, was absolutely based upon the above fact. The mathematical proof was not published till November 28, 1919 (*Chemical News*), because chemists *knew* up to that time that the atomic weights were not whole numbers.

Confirmed by direct experiment by Thomson and Aston, 1920-21.

(2) The Odd and Even Rule.—" Those elements which have even valency have even atomic weight, and those which have odd valency have odd atomic weight."

Discovered and mathematically proved to be true in 1901.

Published in *Chemical News*, October 11, 1907, by Sir William Crookes at request of Sir William Ramsay; and November 14, 1913.

(3) The Interrelationship of the Elements.

Discovered and mathematically proved to be true in 1901.

Published in *Chemical News*, April 9, 1920.

(4) The First Main Principle in the Constitution and Structure of the Chemical Elements—or—The Cause of the Odd and Even Rule — " Single chemical valences emanate from elements or portions (of elements) whose masses are 1, 3, 7, 23 and 39."

Discovered and mathematically proved to be true in 1901-03.

Published in *Chemical News*, January 16, 1914, and December 26, 1919.

(5) The Second Main Principle in the Constitution and Structure of the Elements —or—The Law of the Formation of Nonmetals.—" The non-metallic nature of an element is always due to a pair or pairs of electro-positive forces, each pair emanating from a portion of the element, of which the mass is 4, taking the mass of an atom of hydrogen as unity.'

Discovered and mathematically proved to be true in 1901-3.

Published in *Chemical News*, October 11, 1907, and February 28, 1913.

Confirmed by direct experiment by Soddy in 1912.

(6) The Third Main Principle in the Constitution and Structure of the Elements.—" Monadic Na (23) takes a prominent part in the formation of all elements of greater atomic weight than itself."

Discovered in 1901-03. Published in *Chemical News*, January 16, 1914; December 26, 1919; and October 1, 1920.

(7) The Fourth Main Principle in the Constitution and Structure of the Elements. —" In the simpler elements H(1) forms the connecting link between the other portions 3, 7, 23 and 39. In the formation of the heavier elements, masses of 23 sometimes unite by forces, which are not chemically evident, without any intervening unit mass."

Discovered in 1901-03. Published in *Chemical News*, January 16, 1914; December 19 and 26, 1919, etc.

(8)The Fifth Main Principle in the Constitution and Structure of the Elements.— " Each of the heavier elements is formed by the union of simpler elements (which are indicated in each case by mineralogical and chemical facts combined)."

Discovered in 1901-03. Published in *Chemical News*, October 15 and November 5, 1920.

(9) Helium has two electro-positive valences.

Discovered in 1901-03. Published in *Chemical News*, October 11, 1907, etc.

Confirmed by direct experiment in 1912.

(10) Discovery of Asterium of atomic weight 3 and valency 1.

Discovered in 1901-03. Published in *Chemical News*, October 11, 1907, etc. Confirmed by Thomson by direct experiment in 1913.

(11) The True Atomic Numbers, obtained by the Discovery of their Cause.

Mathematically proved in the *Chemical News*, December 19, 1919.

(12) An Atom of Nitrogen is constituted by the union of two atoms of Hydrogen with one of Carbon.

Discovered on January 1, 1911. Sent to the Nobel Institute in 1914. Published in *Chemical News*, July 18, 1919. Confirmed by direct experiment by Rutherford in 1919.

(13) The Law of Electro-Positive and Electro-Negative Valences.—"The valences which emanate from the metallic portions of

non-metals are electro-negative; all other valences are electro-positive."

Published in *Chemical News*, 1924, cxxxix, 47.

(14) The Relative Volumes of the Chemical Elements, when in combination with one another—or—The Fundamental Constants of Nature.

Discovered on January 1, 1911. By far the most exact and most extensive discovery which had ever been made up to that time. A portion (consisting of 1,425 substances, with as many diagrams) was sent to the Nobel Institute in 1914. Partly published without the diagrams by the *Chemical News*, January 7; February 11; February18 and August 19, 1921. The publication was discontinued because the *Chemical News* could not spare the space required.

(15) The Valences of Carbon are Unequal.—This follows from the fact that in the preceding discovery the four valences are plainly differentiated. Each one of the above-mentioned 1,425 diagrams is a separate and exact proof of the truth of this discovery.

(16) The Law of Relative Volume.—" The relative volume of an atom is the sum of the relative volumes of its parts, any one or more of which may be zero."

Published in the *Chemical News*, 1924, cxxviii, 100.

(17) The Heat of Formation of each one of the Chemical Elements when combining to form molecules.—Mathematically proved to be correct by the discovery of the following law.

(18) The Law of Heat of Formation.—" The Heat of Formation of an Element is Proportional to the Product of the Atomic Weight and the Change of Volume; there being two distinct series, *viz.*, the Sodium Elements, and the Sub-sodium Elements."

Published in *Chemical News*, August 18 and 25, 1922.

(19) The Magnetic Rotation of each one of the elements, when in combination.—Mathematically proved to be correct by the discovery of the following law.

(20) The Law of Magnetic Rotation.—" The Magnetic Rotation of an Electro-Positive Element, when in combination, is the Product of Half its Atomic Weight and the Reciprocal of its Relative Volume."

Published in *Chemical News*, March 29, 1923.

(21) The Correlation of Physico-Chemical Constants; showing the connection between the following series of constants :—Relative Volume (which includes Specific Gravity and Atomic Weight), Magnetic Rotation, Optical Refractivity, Heat of Combustion, Heat of Formation (solid), Heat of Formation (liquid), Heat of Formation (aqueous solution), Heat of Formation (gas), Specific Heat, and Latent Heat.

Sent to the Nobel Institute, 1923.

(22) The Constitution and Structure of Thirty Elements, each one being separately investigated by means of all available facts of S.G., H.F., M.R., and O.R.

Published in the *Chemical News* in about forty papers during the years 1924-27.

(23) The Optical Refractivity of each one of the Chemical Elements, when in combination.—Mathematically proved to be correct by the discovery of the Collinsics.

The certain knowledge obtained mathematically by the investigator in 1901 that the atomic weights are whole numbers gave him a start of twenty years over other scientists. Halfway through that period he discovered the Fundamental Constants of Nature, without which it would have been impossible to discover the Laws of Relative Volume, Heat of Formation and Magnetic Rotation and the Collinsics.

The last discovery has placed the whole matter of the twenty-three discoveries far out of the region of controversy, the reason being that the Collinsics themselves are evidently true, each one containing the proof of its truth on the face of it; and it is impossible to build up something, which is evidently true, upon matter which is not true.

TABLE X.

THE COLLINSICS OF TWELVE MINERALS.

			Theor. Column	Obs. Column	
(73)	Atacamite	$Cu_4 + O + O_2 + Cl_2 + 3H_2O$			
	$98.585 = 0.8699($	$7.13_4 + 7.53 + 2.51_2 + 15.085_2 + 14.03_3)$	**3.75**	3.75	D
	$98.582 =$	$13.22_4 + 1.654 + 1.346_2 + 10.82_2 + 6.572_3$	**1.8699**	1.83-1.88	S

Theor. Column — Obs. Column

(74) Chalcanthite $Cu + S + O_2 + O_2 + 5H_2O$

2.206 — 2.12-2.3 D

$57.83 = 0.5123(7.13 + 15.53 + 7.53_2 + 2.51_2 + 14.03_5)$

1.5123 — 1.5140 D

$57.83 = 13.22 + 5.75 + 1.654_2 + 1.346_2 + 6.572_5$

(75) Spangolite $AlClSO_4.6Cu(OH)_2.3H_2O$

$Al + Cl + S + Cu_6 + O_2 + O_3 + O_5 + 9H_2O$

3.144 — 3.141 D

$175.18 = 0.6933(12.05 + 15.085 + 15.53 + 7.13_6 + 7.53_2 + 4.45_3 + 2.51_5 + 14.03_9)$

1.6933 — 1.694 D

$175.18 = 4.863 + 10.82 + 5.75 + 13.22_6 + 1.654_2 + 1.747_3 + 1.346_5 + 6.572_9$

(76) Dioptase $H_2 + Cu + Si + O + O_3$

3.302 — 3.28-3.35 D

$33.919 = 0.7135(5.76_2 + 7.13 + 13.83 + 7.53 + 2.51_3)$

1.7135 — 1.667 D; 1.723 D

$33.918 = 2.613_2 + 13.22 + 9.78 + 1.654 + 1.346_3$

(77) Antlerite $Cu_3 + S + O_2 + O_4 + 2H_2O$

3.92 — 3.93 D; 3.9 W

$67.245 = 0.7465(7.13_3 + 15.53 + 7.53_2 + 2.51_4 + 14.03_2)$

1.7465 — N_m 1.737 W; N_g 1.785 W

$67.246 = 13.22_3 + 5.75 + 1.654_2 + 1.346_4 + 6.572_2$

(78) Herrengrundite $Cu_3 + S_2 + O + O_8 + 6H_2O$

3.133 — 3.132 D

$103.14 = 0.64(7.13_3 + 15.53_2 + 4.45 + 2.51_8 + 14.03_6)$

1.64 — N_m 1.649 W; N_p 1.585 W

$103.107 = 13.22_3 + 5.75_2 + 1.747 + 1.346_8 + 6.572_6$

(79) Shattuckite $Cu_2 + Si_2 + O_6 + H_2O$

3.77 — 3.79 W

$60.34 = 0.768(7.13_2 + 17.61_2 + 2.51_6 + 14.03)$

1.768 — N_m 1.782 W; N_p 1.752 W

$60.34 = 13.22_2 + 9.625_2 + 1.346_6 + 6.572$

(80) Stilbite $H_4 + Ca + Al_2 + Si_6 + O_{11} + O_7 + 4H_2O$

2.16 — 2.16 D

$143.366 = 0.4944(5.76_4 + 14.54 + 12.05_2 + 17.61_6 + 4.45_{11} + 2.51_7 + 14.03_4)$

1.4944 — 1.494 D

$143.375 = 2.613_4 + 10.52 + 4.863_2 + 9.625_6 + 1.747_{11} + 1.346_7 + 6.572_4$

(81) Gismondite $Ca + Al_2 + Si_4 + O_4 + O_5 + O_3 + 4H_2O$

2.27 — 2.27 W

$112.032 = 0.5419(14.54 + 12.05_2 + 13.02_4 + 7.53_4 + 4.45_5 + 2.51_3 + 14.03_4)$

1.5419 — N_m 1.5402 W; N_g 1.5484 W

$112.043 = 10.52 + 4.863_2 + 11.53_4 + 1.654_4 + 1.747_5 + 1.346_3 + 6.572_4$

(82) Vesuvianite $H_4 + Ca_{12} + Al_8 + Si_{10} + O_{43}$

3.3 — 3.3 D

	Theor. Column	Obs. Column
$357.03 = 0.7287(5.76_4 + 14.54_{12} + 9.05_6 + 13.02_{10} + 2.51_{43})$	**1.7287**	1.7235 D
		N_o1.705 W
		N_o1.736 W
$357.06 = 2.613_4 + 10.52_{12} + 7.865_6 + 11.53_{10} + 1.346_{43}$		
(83) Chrondite $H_2 + Mg_{18} + F_4 + Si_8 + O_6 + O_{28}$		
	3.12	3.125 D
$254.157 = 0.6205(5.76_2 + 8.71_{18} + 5.42_4 + 13.02_8 + 7.53_6 + 2.51_{28})$		
	1.6205	1.619 - 1.639 D
$254.145 = 2.613_2 + 6.0015_{18} + 0.26_4 + 11.53_8 + 1.654_6 + 1.346_{28}$		
(84) Kornerupine $Mg + Al_2 + Si + O_6$		
	3.323	3.27 - 3.34 W
$40.2667 = 0.6625(8.71 + 9.05_2 + 18.91 + 2.51_6)$		
	1.6625	1.6691 D
		N_p1.6613 W
		N_p1.6650 W
$40.2685 = 6.0015 + 7.865_2 + 10.461 + 1.346_6$		

All the above pairs of values for R.V. and O.R. are the same as in the 72 preceding collinsics, the only new introduction being Cu of relative volume 7.13 and optical refractivity 13.22.

U.S. BUREAU OF STANDARDS JOURNAL OF RESEARCH.

Beginning July, 928, a new monthly periodical; *The Bureau of Standards Journal of Research*, continued the publication of the two series of research papers heretofore issued—" Scientific Papers " and " Technologic Papers." Forty-four volumes (22 of each of the two superseded series) have been published, comprising some 942 research papers (572 on fundamental science and 370 on applied science).

The new journal will contain the bureau's research papers and critical reviews in the fields of science and technology. These will be comparable in interest and importance with the bureau papers already issued. The union of pure and applied science in one journal will, it is believed, tend to bridge the gap between the two fields, and by so much shorten the lag between discovery and its application. This makes it the more desirable that all engaged in scientific or technical work should have available for current use and permanent reference the new *Bureau of Standards Journal of Research*. The paper size of the new journal is about that of the *Philosophical Magazine* or the *Annalen der Physik*. Each volume (semi-annual) will be indexed and a cumulative consolidated index will be included in the bureau's list of publications as heretofore.

U.S. Bureau researches concern specifically fundamental science and the laws of matter and energy; physical constants and other basic data in the form of tables, equations, monograms, or other graphs; the properties of materials, structures, and devices and their effective design and performance; the mitigation of injurious effects of such agencies as fire, corrosion, breakage; the promotion of efficiency by scientific measured control of processes through experimental and theoretical research in the fields of physics, chemistry, engineering, and the special technologies.

RESEARCH IN INDUSTRY.

In the course of a lecture before the Royal Society of Arts on " Progress in Industry during the Past Fifty Years," Sir George Sutton, Bt., said:

" The better organisation of industry, both by amalgamation and the formation of associations, has a direct bearing upon the important subject of Research. It used to be a common subject of reproach against our manufacturers that they neglected to research. A generation ago there may have been plenty of ground for the reproach; today it is largely due to the transformation from independent competing firms to co-operating organisations.

Industrial research on the modern scale is a very costly and speculative undertaking. It needs large laboratories, equipped with expensive plant and manned by highly skilled experts in various branches of science. Its purose is to adventure across the frontier between knowledge and ignorance and reach out over the unknown in the hope of discovering a treasure. However skilfully conducted, missions of this sort may only too readily end in nothing.

Clearly no industrial firm can embark on an organised research policy without possessing security, stability and surplus profits. When our industrial picture revealed a number of small and exclusive companies fighting each other gallantly for every order that came along, cutting prices in a desperate effort to maintain output in the face of both home and foreign competition, and experiencing rapid fluctuations of good and bad fortune, there was no place where research could have been introduced. The utmost that could be attempted was the equipmeut of a works laboratory for the testing of materials and for occasional experiments on new inventions. To spend thousands of pounds on a research department and instal in it a physicist, a chemist, a metallurgist and other specialists in the hope that they might eventually achieve some beneficent revolution, was altogether Utopian.

With the growth of organisation, however, the whole situation changes. A large amalgamation or an industrial association can afford to face the cost and accept the chances of research on elaborate lines. The research laboratories to which our attention is so often drawn on the Continent and in the United States are all associated with the largest and most prosperous Trusts. The further we carry our industrial orgauisation either by amalgamation or combination, the more capable we shall become of bearing the luxury—a very profitable one at times—of research.

Let me again draw an example from my own experience. Some years ago the cable-making industry realised that it enjoyed a rather imperfect knowledge of what actually happened to its cables when laid underground. Dimensions and materials had been determined on empirical lines and they were known to be satisfactory in a general way. But no one knew with scientific precision whether the standard sizes of cable were capable of rendering a higher service than that for which they were specified.

The problem was one which concerned every cablemaker; or rather, it concerned the user of cables more than the maunfacturer. A committee was appointed by the Electrical Research Association to investigate the subject of the heating of buried cables, and through the existence of the organisation of the leading cable makers, this joint experience was available for the use of the committee, and the result of this co-operation was that the Electric Supply Authorities were assured that they could egect material economies in their transmission systems.

A further development of joint research is now under way. Each member of the Cable Makers' Association has been engaged upon independent research for a number of years. Their enterprise in this direction is part of the healthy rivalry which is maintained within the circle of the Association. But it is inevitable that several of the cable research laboratories must be engaged simultaneously upon the same problem—as, for example, the behaviour of insulating materials at the extra high pressures now adopted on mains transmitting large quantities of electricity over long distances. Duplication of this kind tends to waste of effort, and arrangements have recently been made for co-ordinating the material and mental resources of many cable research laboratories on the main problems awaiting solution.

In enterprise of this description the British manufacturer finds invaluable aid in the National Physical Laboratory and the Department of Scientific and Industrial Research. Of late years the State has, through these organisations, so efficiently seconded the research work of large industrial firms and associations that we may rest assured that the help which science can render to industry is being adequately exploited.

Education.

Now I come to an aspect of my subject upon which, though it is of great importance, I can do no more than briefly touch. I refer to education, in connection with which this Society has played a most distinguished and useful part.

The fact that the Royal Society of Arts has held this year, examinations, for which there were over 100,000 entries, is proof of a wide-spread desire for education among recruits in the army of commerce. All these candidates desire to excel in some special branch of knowledge. This desire is the only thing that really counts. I feel it would be a waste of public funds to try to force young people to acquire knowledge and proficiency if they have no genuine

desire for the acquisition. Attempts in that direction have been made in recent years, but they have failed in their purpose. Young people should certainly be encouraged and helped to make themselves more proficient for the battle of life, but a voluntary impulse on their part is essential to success.

If we are to make the best of the material which the school provides for the manning of our industrial army, we must enlarge the opportunities for education until they are open to all. The ideal educational system is one which provides a clear course from the elementary school through the secondary school to the University, for those who have the character to avail themselves of it. Educational progress is already tending in this direction, and I think the advance would be accelerated by the provision of scholarships by the State. Some assistance of this kind is essential if equal chances are to be enjoyed by all grades.

Of late years there has been an increasing desire to employ public school boys in industry. Their training fits them admirably in many ways for positions of control, but they labour under the disability that they enter the workshops or offices at a comparatively late age. The lad who goes direct from the ordinary school into employment has gained five or six years' practical experience, and has therefore become definitely useful to the employer, by the time the public school boy comes on the scene.

What the employer wants is, of course, a combination of higher education and practical experience. Under present conditions this combination is generally impracticable and a choice must be made of one or the other. Whether it is possible, by some revision of our system of training, to secure a measure of both qualities in the young men who are fitting themselves for responsible positions, is a problem which our educational authorities should seriously consider.

In this connection I do not overlook the excellent results which have been achieved in technical training when a really great teacher gets around him a body of students attracted by the tradition of his teaching. I have in mind two outstanding examples in the Electrical world, one the old Finsbury Technical College under Professor Ayrton, and the other the Faraday Training Institution under Professor Harrison and Dr. Alexander Russell.

In this review of a half-century of industry I have touched upon some of the principal changes and dealt with important problems which have been solved or still await solution. Surveying this period of our industrial history as a whole, I think it reveals a great deal of solid and enduring achievement, and encourages the confident belief that, if we make intelligent use of our resources, and above all of our human resources, the future will witness a continuous advance in the general welfare.

SYNTHETIC STAGE OF CHEMISTRY.

Mr. H. T. F. Rhodes, general secretary of the British Association of Chemists, speaking at the annual dinner of the Association at Birmingham on November 17, said that chemistry began, as most sciences had begun, with analysis and with the destructive examination of things to find out of what they were really made. Chemical science had now entered upon its second phase, synthesis—the building up and the making of new and valuable products out of the meaner ones as a practical proposition. The artificial production of dyes and of silks were two examples in this work of synthesis. It was a question of knowing the exact composition of a given material. Sooner or later its artificial production would follow as a matter of course, and the speculation was almost forced upon us as to whether it would be possible in the end to create living material. We knew the composition of protoplasm, that substance which was the basis of life, and which was carbon, hydrogen, oxygen, and nitrogen, and there seemed to be no reason to doubt that the chemist would in the end accomplish its synthesis and thus cause life to manifest itself.

IMPROVED ORGANISATION FOR SCOTTISH AGRICULTURE.

Consolidation of Scottish Fertiliser and Feeding Stuffs Trade.

Formation of Holding Company by Imperial Chemical Industries, Ltd.

For some time past rumours have been current to the effect that steps were being taken to bring together the principal fertiliser and feeding stuffs manufacturers of Scotland. Negotiations have now reached such a stage that it is possible to announce that a Company, to be designated Scottish Agricultural Industries Limited, is in course of formation and will acquire the greater part of the capital of the following companies :—

Alexander Cross & Sons, Ltd., Glasgow.
Cross's Chemical Co., Ltd., Falkirk.
J. & J. Cunningham, Ltd., Leith.

John Miller & Co. (Aberdeen), Ltd.
Charles Tennant & Co., of Carnoustie, Ltd.
Daniel Wyllie & Co., Ayr.

The nominal capital of Scottish Agricultural Industries will amount to £1,750,000.

The scheme has been prepared by Imperial Chemical Industries Limited, who are taking a substantial interest in the new Holding Company.

The directorate of the new Company is an influential one under the chairmanship of Sir Harry McGowan, President of Imperial Chemical Industries, Limited. The registration will shortly be effected in Edinburgh and the vendor companies will be taken over as from the 1 January, 1929.

It is hoped that this new development will contribute in a practical way towards the solution of the farmer's present difficulty of reducing his costs of production. There can be no doubt that the agricultural industry is going through a period of depression that is world-wide, and it is difficult for any official or palliative measures to lead to better results under such conditions. It remains, therefore, for the industry itself and for those associated with it, to take all possible steps to reduce the cost of production in any direction where this appears practicable.

There have been several recent developments in the manufacture of fertilisers. Nitrogen is being produced from the air at the Billingham Works of Imperial Chemical Industries, Limited, and this has already resulted in lowering the price of all nitrogenous fertilisers. The process entails enormous capital expenditure which cannot be faced by small undertakings. Developments, again, are at hand whereby it will soon be possible to supply complete fertilisers containing all the necessary ingredients in a highly concentrated form.

Individual companies in times of depression have to keep their works going on a restricted and often uneconomical output; and further, in order to maintain their separate positions they have to duplicate expenditure in distribution and in overhead charges which might otherwise be saved.

Scottish Agricultural Industries Limited will be able to deal with all these problems, and its intended policy is to restrict its dividends within reasonable limits with the object of benefiting its consumer customers in the future.

The merger companies will have direct representation by means of their branches and subsidiaries in almost every local market in Scotland from the Pentland to the Solway Firth. Representatives of the constituent companies will as far as possible continue to deal with their old customers and thus develop their existing trade in fertilisers, feeding stuffs, agricultural seeds, home grown grain and all farm requisites and products.

Scottish Agricultural Industries Limited will have at its disposal vast manufacturing and research resources, and the pooling of the energies, experience and organisation of the leading firms in Scotland should result in placing the manufacture and marketing of fertilisers and feeding stuffs in that country on a rational and economic basis.

GENERAL NOTES.

THE WORLD'S BUYERS AND BRITISH INDUSTRIES.

An increase of over 300 per cent. in the number of overseas buyers who have promised to attend the next British Industries Fair was revealed this week by Mr. Douglas Hacking, M.P., Minister of the Department of Overseas Trade, as a result of a comparison made with the replies received up to the corresponding date last year.

" In a single batch of replies to the Government's invitation which one of my officers brought me," said Mr. Hacking, " I was astonished to find that there were only two refusals in the lot. The rest were definite promises to come to the Fair, except two in which the writers said that they hoped to come should circumstances permit.

" I asked whether this was an exceptional case. The reply was that during the previous three days mails had been received from Holland, France, Belgium, and Italy which showed large numbers of visitors who have promised to attend. Similar mails are being received almost daily.

" There is also a 100 per cent. increase in the number of replies stating that the United Kingdom agents of overseas firms have been instructed to attend the Fair.

" In addition there is a very large all-round increase in the total number of replies received, which shows that our campaign is 'geting home,' so to speak, while the proportion of acceptances of our invitation as against refusals is not merely rising from year to year; it is positively jumping ahead."

The Fair is to be held at White City, London, and Castle Bromwich, Birmingham, from February 18 to March 1.

PROGRESS AT BIRMINGHAM'S NEW SUPER POWER STATION.

If the progress already made is maintained, as is almost certain, the new Super Power Station at Hams Hall, near Birmingham, will probably create a record. According to Mr. R. A. Chattock, the City Electrical Engineer, the original idea of completion in twenty months is well in sight. The site is practically in the centre of four large coalfields, *viz.*, The Staffordshire, Leicestershire, Nottinghamshire and Warwickshire collieries, and the new station will serve as a base load station under the Central Electricity Board scheme. A large "frid" sub-station will connect it with all the other large centres in the district, and the generating capacity of Hams Hall will, finally, be the largest of any connected stations.

It will be recalled that the order for this station was the largest single contract ever placed as one order, and the progress which was visible when a visit was paid to the site on Saturday, November 17, by the Institution of Electrical Engineers, fully justifies entrusting the work to the firm of International Combustion Ltd., as main contractors. The difficulties and delays encountered during the wet summer of 1927 and the following severe winter were met by intensive organisation and the close co-operation of the sub-contractors and the City Electrical Engineer, and the effect has resulted in what Mr. Chattock describes as phenomenal progress.

The building and civil engineering work covers not only a main road to the site and railway sidings, but also a reservoir with 5,850,000 gallons capacity, enormous cooling towers, of reinforced concrete, and extensive buildings comprising the power house, boiler house, switch house, control room and offices, and the coal storage with its excavation and concrete work.

For the present the plant's generating capacity will be 60,000 K.W., but the buildings now being erected will accommodate an extension to a total of 90,000 K.W. Pulverised fuel firing, which has come so prominently to the front in large modern power stations, will be used for raising the steam for driving the turbo-generators, and the plant will embody the latest patent design of "Lopulco" combustion chamber, lined with Murray fire tubes, the contractors' latest 'R" type turbulent burners, large "Usco" air heaters, and other auxiliaries for obtaining the best efficiency. Pulverisers for the fuel will be supplied by Alfred Herbert & Co., Ltd., draught plant and dust collectors by Davidson & Co., Ltd., ash sluicing plant by Underfeed Stoker Co., Ltd., raw-coal handling plant by the Mitchell Conveyor and Transport Co., Ltd., and the pressure parts of the boilers will be contributed by Babcock and Wilcox, Ltd.

The turbines are being made by Fraser and Chalmers, Ltd., and the General Electric Company will supply the electricity generating plant. When completed the station will represent a notable achievement in British power plant construction, both as regards its equipment and the remarkably short time involved from commencement to completion.

DEMOCRITUS, B.C. 460-370.

A CORRECTION.

On Page 324, last week's issue of this Journal, the sentence beginning 12th line down in 1st column is incomplete. It should read :—"They are invisible by reason of their smallness, indivisible by reason of their solidity, and unalterable."

Proceedings and Notices of Societies

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Shin-ichiro Hakomori : "On the Reaction of Hydrogen Peroxide with Some Metallic ions. Potential of Hydrogen Peroxide. Part II. Alleged Reduction Coefficient of Hydrogen Peroxide Electrode."

Ei-ichi Shibata : "A New Method for Preparing Normal Solutions of Caustic Alkali free from Carbonates and the Reaction between Amalgams of Alkaline Metals and Water."

Sotoji Takagi : "Reaction between Active Nitrogen and some Organic Compounds."

Junzo Arima : "On a Glucoside in the Root of Pencedanum decrusvum Maxim. Part V. Constitution of Nodakenin.

Takeyu Takahashi : "On the Essential Oil of Nothosmyrnium japonicum. I. Nothosmyrnol.

THE PHYSICAL SOCIETY.

Friday, November 23.

The following papers were read :—

The Physical Interpretation of Wave Mechanics. By G. Temple, Ph.D.

The object of this paper is to give an account of the fundamental principles of wave mechanics in a manner which shall make clear the physical significance of all the quantities and processes involved. The principles are illustrated by discussions of the propogation of free electric waves in uniform electro-magnetic fields, and of bound electric waves in the hydrogen atom. The paper concludes with relativistic wave mechanics (prior to the work of Dirac and Darwin) and a short account of the Compton effect.

The Effect of Superimposed Magnetic Fields on Dielectric Losses and Electric Breakdown Strength. By Allan Monkhouse, M.I.E.E., A.M.I.Mech.E.

A description is given of tests made to determine the effect of superimposed magnetic fields on the insulating properties of dielectrics. As a result of the tests made the author reaches the conclusion that both the electric strength of dielectrics and the dielectric losses in the same are seriously affected by the presence of superimposed magnetic fields. A theoretical explanation of the phenomena is suggested by a paper read by Prof. A. Smouroff before the Mathematical Conference at Bologna in September, 1928. The investigation is not complete and the author is proceeding with dielectric loss measurements, using more refined laboratory apparatus than that which he had available for the series of tests described.

A New A.C. Potentiometer of Larsen Type. By Albert Campbell, M.A.

The instrument is a modification of the simple Larsen A.C. potentiometer, in which the unknown voltage is balanced by another (v_1) of the form $(r+j\omega m)i_1$, where i_1 is a constant standard current and r and m are resistance and mutual inductance, both variable. In the simple type the quadrature component, ωmi, is obtained by multiplying the observed mi by the pulsatance ω, *i.e.*, $2\times$ frequency. The new system avoids this trouble by ensuring that at any given frequency the current through the primary of the mutual inductance shall be such a multiple of i_1 as to make the balancing voltage $(r+jbM)i_1$, where M is the mutual inductance and b a constant. This is achieved by an arrangement of loop-shunt which can be set for any given frequency, so that the readings of r and bM shall give the two components directly in millivolts. The standard alternating current i_1 is set and held constant by a thermal null method in which it is balanced against a known direct current.

Ferromagnetic Ferric Oxide. By Prof. E. F. Herroun, F.I.C., and Prof. E. Wilson, M.Inst.C.E., M.I.E.E.

A brief account is given of work relating to the above subject that has been published during the past eight years. The authors confirm the observation by Messrs. Sosman and Posnjak that lepidocrocite, but not göthite, yields on dehydration a strongly ferromagnetic ferric oxide. As all the specimens of lepidocrocite examined contained 3 or 4 per cent. of manganese oxide, they suggest that this substance may be an essential constituent of this crystalline form of the hydrate. They find that the temperature at which the ferromagnetic oxide is permanently transformed into the common paramagnetic kind is largely dependent upon its mode of preparation.

A table showing the magnetic force at which magnetic permeability and susceptibility reach their maximum values, as well as the coercive force and remanent magnetisation, is given for different kinds of magnetic ferric oxide and for magnesium and copper ferittes in the form of compressed rectangular bars. Comparative figures are given for two varieties of natural magnetite. Curves are also given showing the variation of permeability with field strengths ranging from 25 to 1800 c.g.s. units. Although copper ferrite has a higher maximum permeability than ordinary precipitated magnetic oxide of iron, it falls far below that of the purer forms of native magnetite.

Analyses of several magnetites are given, and the high or low values of the susceptibility of the ferric oxide resulting from their oxidation are attributed to the presence or absence of impurities, particularly magnesia, which forms a magnetic ferrite.

A Demonstration of Emulsions showing Chromatic Effects was given by R. H. Humphrey, M.Sc., The Sir John Cass Technical Institute.

INSTITUTE OF FUEL TECHNOLOGY.

Delivering the Presidential address at the Autumn meeting of the Institute of Fuel, on Tuesday, November 21, the President, Lord Melchett, F.R.S., said that this was the last time he would address them as their President, for Sir David Milne Watson had consented to accept the Presidency, but as their Founder President he would do all

he could to further the interests of the Institute.

The fuel and coal industries of the country were unbalanced, and although good in some parts were in a bad condition in others. Looking back on the history of Britain it was evident that coal was a comparative newcomer in the national life. The industrial revolution and the general use of iron as a substitute for wood gave a great impetus to the coal trade. Britain took the lead because besides inventive genius she had energy and practical application. She had the great natural advantage of coalfields near the sea and iron at reasonable proximity to the coal. This lowered export costs of manufactured products and developed the export coal trade.

The first phase of the industrial revolution had spent its force, the second was well on its way towards practical results. Let them contrast modern tendencies in progressive industry with the spectable of three thousand independent collieries, each working its own pits in its own way. They in the Institute of Fuel were continually endeavouring to make substantial economies in the use of fuel. Britain used in manufacturing in collieries themselves, in domestic consumption and in railways a very large proportion of her home consumption. They all knew that the amount used in these categories could be greatly decreased and were steadily attacking the problem.

Steam generating plants, for example, were constantly increasing their pressures, a new boiler plant under erection in one of the factories of Imperial Chemical Industries would shortly generate steam at a higher pressure than any other in the country, and produce electricity cheaper than anywhere in the world.

The coal trade was faced with the problem of tiding over the present period of disorganisation and over-production in such a way that the world's output of coal when used with the greatest economy would satisfy its needs. The formation of the Fuel and Power Committee, of which he was chairman, showed that the country was taking the fuel question seriously. He wished particularly to draw their attention to the suggestion contained in the Fuel and Power Committee's report that the coke oven industry should centralise their research.

The unemployment in the coal industry was a serious factor in the total unemployment of Britain. Nearly 300,000 miners were unemployed. It was said that between 200,000 and 250,000 were a permanent unemployable surplus in the industry. It was a desperate load for an industry to assume and the general desolation caused was almost too dreadful to think about. Efficiency was necessary not only in technical achievement but in organisation. The coal situation was a world problem. During the coal strike he had done his utmost to impress the importance of a rational organisation, particularly on the selling side. A certain amount had been done in the meantime; 80 per cent. of the anthracite industry was merged, the Five Counties scheme was a great step forward, because it brought production into relation with demand. It was the height of folly to sell anything at an unremunerative price. A coal selling scheme for South Wales was under discussion, also meetings contemplating a national scheme were being held.

Particular movements both technical and otherwise called for comment. Powdered fuel plants were on the increase. A great public utility company had taken up the coalite low temperature carbonisation process. Coal should be sold in a better classification, there should be a standardisation in screening. He would like to draw their attention to Dr. Lessing's coal cleaning method which was being operated by one of the companies in which he was interested. The process dependent upon the relative densities of the wanted and unwanted portions of coal in a suitable medium. Contrary to expectation no difficulties in removal of the flotation medium had been experienced. Coke made from coal thus cleansed was low in ash and reduced production costs in pig iron.

The combustion engineer nowadays was an important person. Much greater attention was devoted not only to his training but to the training of all fuel personnel. They all knew the difference to consumption a good stoker made in hand firing. The worker was not a machine; sympathetic and intelligent training produced workers who were genuinely anxious to get and maintain the best technical results. The Institute of Fuel had instituted a fellolwship that was a real mark of technical distinction. The regulation had been drawn up so as to include both academic and technical ability. The institute owed a debt to Prof. M. W. Travers, F.R.S., the chairman of the committee who had drawn up the Fellowship regulations.

If they considered the present position of the coal industry of Great Britain they might be able to learn some lessons for the future. In spite of the total lack of any organised method of selling before the war

Great Britain had developed a great and important export coal trade. She was a pioneer and had reaped the pioneer's reward. The war vastly accelerated those forces which were working against industries which did not keep pace with modern world tendencies. During the unhappy period of the war steel production increased to prodigious figures. Thousands of skilled men were withdrawn from the coalfields to serve in the army.

At the conclusion of the war a large fraction of the miners originally withdrawn returned but the majority of their substitutes were not displaced. The spurious prosperity of the war and post-war periods culminating with the boom of 1920 followed by an unparalleled depression due in part at least to over-rapid deflationary policy had as its inevitable sequel, a time of continuous industrial turmoil together with strikes both sporadic and wholesale. It must not be forgotten that disputes in the coal industry had been a decisive contributory factor in placing it in its present position. Foreign manufacturers who had been before the war accustomed to depend upon a cheap and continuous supply of our feul, were unable to obtain it and naturally and inevitably fell back upon their own resources.

The German problem in some respects resembled their own. Germany lost part of her coal fields in Silesia and Lorraine. Her export markets contracted whilst at the same time her home supplies diminished. In Germany, however, the position was different from that of Britain. Germany had already had to bear the brunt of a most formidable British competition for over a generation. Her coal industry had accordingly organised itself through various coal selling and price controlling associations. Prices had been regulated and a fair price obtained at home for the coal, and unco-ordinated competition in the export markets had been avoided.

It was not going much too far to say that had the commercial organisation of the German coal industry not been in a satisfactory condition before the war that it could never have weathered its post-war difficulties.

Lord Melchett urged that the coal problems of the world were one. A particular country might have a particular disadvantage but if they examined the question closely they would find that frequently there were compensating advantages.

The main factor in the re-establishment of the coal industry of this country on a sound economic basis was its internal reorganisation in technology, commercial directions and labour relations, followed by imperial and international reorganisation and agreement.

Countries like their own which depended upon export to a considerable extent would have to make an arrangement with other coal-producing countries. Internal reorganisation should take place promptly. In what other industry would unproductive units be tolerated such as were seen in the coal trade the world over?

On the technical side of the fuel industry there were great possibilities for the future. The getting of coal in the past had been a craft but here as in most other industries the man is being partly replaced by the machine. Our mining engineers are second to none and are subjected to a great amount of totally unfair criticism. The best of our mines were in the first rank.

The general fnel problem facing this country was an extremely complicated one. They were frequently faced with the rival claims of gas and electricity. There should be no such rivalry. There was another side of the coal problem which had not received sufficient attention. Someone years ago had called coal carbon. But coal was anything but that. The first of the problems depending on the fact that coal was not carbon but a complicated hydrocarbon was already being tackled with energy. He was referring to the conversion of coal into oil which would undoubtedly yield an economic solution in the next decade. Further the problem of the direct employment of coal for what it is, namely, a complicated chemical substance, was as yet in its infancy.

Concluding, Lord Melchett said that he need not mention again the truism that any revival in the coal trade would have direct and immediate effects upon the general prosperity of industry and of the whole country. How was such a revival to be brought about? He had already suggested that technology, commercial reorganisation and industrial co-operation were those directions in which the fateful course of British industry and particularly the British coal industry might again tread the path of progress and prosperity. Along these directions, that revival in trade and commerce which the country and its population, employed and unemployed, so earnestly desired and so wistfully looked for might be achieved. In that achievement, in the successful inauguration of the second phase of the Industrial Revolution, there are few bodies which could render greater service than the Institute of Fuel.

ARTICLED PUPILS IN CHEMISTRY.

In its October issue the Report of the Proceedings of the Institute of Chemistry of Great Britain and Ireland says :

From time to time the attention of the Institute is directed to cases wherein students have become articled pupils to chemists in independent practice, and, at the end of their term, through lack of proper advice, have found themselves without sufficient knowledge and experience to enable them to continue in chemical work.

In such cases they have frequently paid premiums up to an amount which would have been sufficient to pay for at least two years' systematic training in a recognised university or college, or in some cases they have paid premiums which have been returned to them by way of weekly salary.

The main objections to the system of articled pupilage in chemistry arise from the fact that the education of a chemist involves something beyond such articled pupilage. Professional education under this system cannot be successful unless it is accompanied by attendance at classes, not only in chemistry, but in physics, mathematics and allied subjects, and it is well known that this method of preparation imposes a severe physical and mental strain on youths who are thus required to work both day and evening. In many cases, where such youths are engaged as paid laboratory assistants, this is the only course open to them, but comparatively few are strong enough to bear the strain over a period of years.

The system of articled pupilage, moreover, usually introduces specialisation before any real foundation of scientific knowledge has been laid; whereas it is generally held that specialised experience should come after the student has taken a degree or the Associateship of the Institute. In any event, the Council of the Institute holds very strongly that Fellows or Associates should only take pupils who have passed an approved preliminary examination of matriculation standard and should then advise them to become registered as students of the Institute and to take systematic courses in the requisite subjects in a recognised institution.

All registered students whose applications are accepted on the nomination of a Fellow in independent practice or in works are warned, at the time of their admission, that such systematic training is necessary, in order that they may eventually become qualified, and are further required to submit periodically progress reports signed by the Fellows under whom they are working, respectively. It may be noted, moreover, that the Headmaster's Employment Committee of the Ministry of Labour issues, from time to time, a warning to the Secondary Schools in the Metropolitan area, that boys leaving school should not be placed under articles with private practitioners in chemistry without the Institute being consulted.

Students whose parents can afford to pay premiums are better advised to attend a university or college for systematic professional education until they have graduated or obtained the Associateship of the Institute. When a chemist has graduated or has obtained his Associateship, however, he may often find it worth his while to obtain specialised experience either by continuing at college ,or by arranging to work under a practitioner on reciprocal terms or for a salary, according to circumstances.

NOTICES OF BOOKS.

The Problem of Fermentation. By M. SCHOEN, with an Introduction by PROF. A. FERNBACH. Translated by H. LLOYD HIND, B.Sc., F.I.C. Pp. xii + 211. London: Chapman & Hall. 1928. Price 21s.

Mr. Hind has taken the trouble to present to English readers the work of M. Schoen of the Institut Pasteur on the facts and hypotheses of fermentation processes.

The problems of fermentation have attracted the keenest interest of scientific workers for generations since it constitutes "one of the most striking and extraordinary reactions presented by chemistry."

Lavoisier attempted to investigate the processes but did not proceed very far. Gay-Lussac, Liebig, Dumas, Pasteur, Berthelot, Claude Bernard, Duclaux and Buchner have all contributed to the study of alcoholic fermentation. Whilst Lavoisier confined himself to the chemical mechanism and Gay-Lussac demonstrated that the sugar gave approximately equal amounts of alcohol and carbon dioxide it was Pasteur who made the greatest progress by considering the biological aspects.

The next great advance was by Buchner, who extracted the enzyme, zymase, in 1897, and showed that it was the agent of fermentation.

Later it was found that there are many ferments and different processes of fermentation and it has now become a question as to what is to be regarded as a *normal* fermentation for glycerine can become the main product of sugar fermentation under certain conditions.

The accessory products in fermentation have also been carefully studied in the last two decades. Mention is made of the production of lactic acid, pyruvic acid, aldehyde and butyric acid. The part played by the structure of the sugars, the *rôle* of phosphates, and effect of hydrogen ion concentration are all discussed in this important volume, the value of which is enhanced by an extensive and up-to-date bibliography.

International Temperature Scale. By G. K. Burgess, being a reprint from the *U.S. Bureau of Standards Journal of Research*, October, 1928. This pamphlet is sold by the Superintendent of Documents, U.S. Government Printing Office, at 5 cents. Pages 635 to 640.

This research concerns the adoption of an international temperature scale having been submitted for discussion by the Bureau of Standards, the National Physical Laboratory, and the Physikalisch-Technische Reichsanstalt. Agreement has been reached for a scale of temperatures ranging from that of liquid oxygen to that of luminous incandescent bodies. One example will serve to show the development after having fixed the basic points. Temperature of equilibrium between solid and gaseous carbon dioxide = $-78.5°$ C. $t_p = t_{760} + 0.1443 (t_p + 273.2)\log_{10} (p/760)$.

Thermal Expansion of Magnesium and of its Alloys. By P. Hidnert and W. T. Sweeney. A reprint, as in the previous case, price being 10 cents. Pp. 771 to 792.

Linear thermal expansion data given for materials as in title above, being investigated over a temperature between $-183°$ and $+500°$ C. For example, the following is an average equation giving the expansion of magnesium between 20° and 500° C.

$$L_t = L_0[1+(24.80t+0.00961t^2)10^{-6}].$$

Two figures of apparatus shown (half-tones), and many tables, diagrams, and curves, supplied relative to the total number of pages. The alloys are :—Mg-Al; Mg-Al-Mn. A summary is given on p. 791.

Tables of Theoretical Zeeman Effects. By C. C. Kiess and W. F. Meggers. This is also a reprint, as in the cases above, price being 15 cents. Pp. 641 to 684.

The authors give the following abstract : The splitting of spectrum lines into components, when the source is in a magnetic field, being the Zeeman effect, furnishes theoretically an absolute identification of the terms involved in the production of the lines. Based on the theoretical work of Landé, the Zeeman effects of various term-combinations have been computed, and these are now presented in tabular form. [Almost the whole pamphlet consists of these tables set up in small type.] The tables give results for terms from S to I in the doublet, quartet, sextet, and octet systems; in the triplet, quintet, and septet systems; and in the doublet-quartet, quartet-sextet, sextet-octet, singlet-triplet, triplet-quintet, and quintet-septet intersystems.

The authors acknowledge their indebtedness to Prof. H. N. Russell, of Princeton University, who kindly checked the tables with those computed by him.

F. H. L.

Annual Tables of Constants and Numerical Data, Chemical, Physical, Biological and Technological. Vol. VI. (1923-1924. 2 vols.; 4to; containing xxxiv pp. of general information and 1,674 pp. of numerical tables. United States of America and Canada : McGraw Hill Book Co., Inc., 370 Seventh Avenue, New York. Other countries : Gauthier-Villars & Cie, 55, Quai des Grands-Augustins, Paris VI. Price, paper covers, 530 fr; bound, 610 fr. ($25).

This volume is the first of the second series of the Annual Tables. It contains all the numerical data that has appeared in the scientific publications throughout the whole world for the year 1923-1924.

As compared to previous volumes, Volume VI offers a number of important improvements, and, in particular, the addition of detailed indexes to a certain number of chapters and of lists of bodies which will be a great aid for purposes of reference.

The Volume also contains several new chapters compiled by experienced specialists : Photography (Dr. W. Clark), Radio-electricity (Mr. Mesny), Geophysics (Prof. Ch. Maurain).

We would finally point out that in the chapter " The Art of the Engineer and Metallurgy " all the texts are given at the same time in English and French.

The improvement, which will certainly be appreciated by English-speaking readers, will be made throughout the whole of Volume VII (1923-1926), which will be published in the course of 1929.

Anyone requiring information about the Annual Tables can write to Prof. Charles Marie, General Secretary of the International Publishing Committee, 9 Rue de Bagneux, Paris (VI°), who will be pleased to send free specimen copies of the separately printed sections of certain of the chapters, such as Spectroscopy, Photography, Radio-Electricity, Electricity, The Art of the Engineer, etc.

IODINE AND ANIMAL LIFE.

Mr. F. E. Corrie, B.Sc., etc., has compiled a pamphlet on "Iodine and Livestock." The significance of such inorganic substances as lime, phosphates, potash and iron in animal life is now well established, but the importance of iodine has escaped attention. This element seldom occurs in abundance and is becoming scantier everywhere except in coastal regions. Soil and plants are becoming deficient in the element and consequently its assimilation by animals is becoming less satisfactory. Mr. Corrie adduces much data and statistical information to show its necessity for producing and maintaining healthy animals and the pamphlet (published by De Gruchy, 45, Mitchell St., London, E.C.1.), is worthy of the attention of agricultural chemists, economists and others.

RADIUM.

The attention now being focussed on the beneficial and curative properties of Radium and its preparations make the article on the Radium Mines of Jáchymov which appeared in *The Chemical News* on October 12 (this vol., p. 226) of special interest. The efficacy of "mud" baths was mentioned in this Journal (July 13, vol. cxxxvii, p. 20). These articles may also be consulted for information concerning table waters which show slight radio-activity. The latter reference and also the article, "The Waters of Some Czechoslovak Health Resorts (*The Chemical News*, 1927, cxxxv, 169) conclude with bibliographies on the subject.

Forthcoming Events.

ROYAL INSTITUTION.

Monday, December 3, at 5 p.m.—General Meeting.

Tuesday, December 4, at 5.15 p.m.—"Diamonds." By Sir William Bragg, F.R.S.

Thursday, December 6, at 5.15 p.m.—"Human Speech and Expression by Gesture." By Sir Richard Paget.

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, December 5, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read:—

"The Natural Occurrence of Boric Acid in Fruits." By A. Scott Dodd, B.Sc., F.I.C. (Work done under the Analytical Investigation Scheme.)

"Chemical Tests for Drunkenness." By John Evans, F.I.C., and A. O. Jones, M.A., F.I.C.

"The Analysis of Mixtures containing Acetone Ethyl Alcohol and Iso-propyl Alcohol." By C. A. Adams, B.Sc., F.I.C., and J. R. Nicholls, B.Sc., F.I.C.

"The Specific Gravities and Immersion Refractometer Readings of Dilute Mixtures of Acetone and Water." By J. R. Nicholls, B.Sc., F.I.C.

"The Wijs Method as the Standard for Iodine Absorption." By J. J. A. Wijs.

Eleven Candidates for admission to the Society will be balloted for.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

33,187.—I. G. Farbenindustrie Akt.-Ges.—Production of oxides of nitrogen. November 13th.

33,610.—I. G. Farbenindustrie Akt.-Ges.—Production of phosphoric acid, etc. November 16th.

Specifications Published.

300,142.—British Celanese, Ltd., Bader, W., and Green, S.J.—Manufacture of methyl alcohol and agents for use therein.

300,286.—Macallum, A. D.—Synthesis of aromatic arsenic compounds containing iodine.

276,972.—Busching, W.—Denitration of waste sulphuric acid mixtures.

300,348.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges). — Manufacture and production of solid calcium cyanide and double compounds thereof with ammonia.

279,812.—Caro, Dr. N., and Frank, Dr. A. R.—Production of the cyanamides of calcium and magnesium.

Abstract Published.

297,777.—Sodium perborate. — Roessler & Hasslacher Chemical Co., Perth Amboy, New Jersey, U.S.A.

Sodium perborate is obtained by treating a borax solution first with sodium peroxide, preferably at temperatures between 12° and 20° C., say at 15° C., until metaborate and some perborate is formed, and then with hydrogen peroxide, preferably at temperatures between 8° and 12° C., say at 10° C., to complete the oxidation. Preferably 1 mol. of sodium peroxide and 3 of hydrogen peroxide are used for each mol of borax, whereby the crystals of perborate obtained by cooling the final solution, say to 0° C., are free from impurities and the mother liquor may be used in a succeeding operation. An example of the manner in which the process may be carried out is included in the Specification.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

IRADIOSTOL.

405,743.—Chemical substances prepared for use in medicine and pharmacy.—The British Drug Houses, Limited, 16 to 30, Graham Street, City Road, London, N.1. November 21st.

PITRAPHORIN.

495,962.—Chemical substances prepared for use in medicine and pharmacy.—Schering Kahlbaum Aktiengesellschaft, 170 and 171, Mullerstrasse, Berlin, N.39, Germany. November 21st.

LYSOVET.

496,125.—Chemical substances in class 2.—Solidol Chemical, Limited, 16, St. Helen's Place, London, E.C.3. November 21st.

PERIO.

494,786.—Chemical substances prepared for use in medicine and pharmacy, but not including medicated kapok and not including any goods of a like kind to medicated kapok.—Henry Francis, 14, Grove Parade, High Road, East Finchley, London, N.3. November 21st.

THE CHEMICAL NEWS
AND JOURNAL OF INDUSTRIAL SCIENCE.

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ON THE ORIGIN OF MAGNETISM BASED ON THE STRUCTURE OF ATOMS.*

By K. HONDA.

SYNOPSIS.

It is shown in the present paper that electrons revolving round the nucleus of atoms have each a magnetic moment, but cannot be magnetised by the action of the magnetic field, and that they cannot therefore constitute the seat of the ferromagnetism and paramagnetism, although they do give rise to the diamagnetism.

According to the present writer, the origin of the ferromagnetism and paramagnetism is in the revolving electrons within the nucleus itself, in which the radii of the orbits are small and the electron velocity extremely high, approaching that of light. Thus, while in the ordinary theory, the origins of ferromagnetism, paramagnetism, and diamagnetism is in every case attributed to the optical electrons in the atom, the present theory considers the ferromagnetism and paramagnetism to be due to nuclear electrons, the diamagnetism being attributed to the outer or optical electrons as usual.

1.—In the electron theory of magnetism it is usual to attribute the origin of the magnetism to the electrons revolving round the nucleus of the atoms, these electrons at the same time causing the light emission. [When they drop from an outer orbit to an inner one line spectra are produced.] It is true that revolving electrons have each a magnetic moment corresponding to their velocity and to the radius of their orbits; but these electrons or elementary magnets cannot be magnetised by the action of an external magnetic field. For, as has been shown by Larmor, on being acted on by the magnetic field, they will make only the precessional motion known by his name, the angle between the magnetic axis and the field remaining unchanged; hence the component of the magnetic moment in the direction of the field is not changed by the

* The 201st report from the Research Institute for Iron, Steel and Other Metals. This paper has already been published in German in *Zeitschr. für Physik*, 1928, 47, 691. Prof. Honda has made magnetism a life study and his researches are well known. This paper appeared in the *Science Reports of the Tohoku Imperial University*, 1928, vol. XVII, No. 6, September. I have arranged all the equations for *machine composition*.—F. H. L.

application of the field; that is, these magnets cannot be magnetised. But as shown below, they give rise to the dimagnetism of the atom to which they belong. In making Larmor's precession, the electrons retain their initial orbits with their velocity unchanged, and as a whole, are revolving about the direction of the field. This last motion gives rise to the dimagnetism of the atoms. If θ be the angle between the axis of an orbital electron (e, m, r) and the direction of the field H, it can be shown that the diamagnetism due to the revolving electron will be

$$\Delta M = -(e^2r^2/4m)(\cos^2\theta + \tfrac{1}{2}\sin^2\theta)H.$$

From the above, it is to be concluded that though the ferromagnetism and paramagnetism cannot be explained as the effect of a system of revolving electrons, these electrons give rise to the diamagnetism. This conclusion evidently applies also to the case of spinning electrons.

2.—Let us consider the magnetisation of a molecule consisting of two or more atoms and take for simplicity the case of the model known as the hydrogen molecule. In this model, two electrons are revolving in a circular orbit in diametrically opposite positions, and two protons are symmetrically situated on the axis of the orbit on its opposite sides. This system may be considered to be a gyroscope, and hence its motion under the action of a magnetic field is equivalent to that of a gyroscope acted on by the force of gravity. From the theory of the gyroscope, it is to be concluded that the above model of the hydrogen molecule will make a precession and a nutation under the action of a magnetic field. Now the nutational motion is a periodic motion of the magnetic axis of the molecule between the initial angle θ and an angle less than θ, and hence it contributes a certain amount to the magnetisation. On the other hand, as has been already shown, the precessional motion has no relation to the magnetisation, but gives rise to a certain amount of diamagnetism. Hence the total effect of magnetisation is the difference between these two magnetisations due to the nutational and precessional motions.

Again, the magnetic moment M and the moment of momentum p of the revolving electrons are given respectively by

$$M = 2\pi er^2/T \text{ and } p = 4\pi mr^2/T,$$

T being the period of the orbital motion. Therefore

$$p = (2m/e)M.$$

That is, the magnetic moment is proportional to the moment of momentum. But from the theory of the gyroscope, it is evident that the moment of momentum of the system in the direction of the field remains unchanged by its action; hence the same must hold good for the component of magnetisation, and therefore the model cannot be magnetised. In other words, the magnetisation due to nutation is exactly equal and the reverse of that due to the precession.

In the above theory, it has been assumed that the orbital motion of the electrons is not in the least affected by the application of the field; but, as a matter of fact, it undergoes a slight change in their velocity, such change resulting in the diamagnetism of the molecule. Hence, it is again to be concluded that the molecule consisting of these two atoms cannot be magnetised by the action of the field, but gives rise to the diamagnetism.

The model of the hydrogen molecule above referred to is usually believed to be paramagnetic. This conclusion is, however, not based on any dynamical theory of electrons, but is merely a consequence of the assumption of the distribution law given by P. Langevin.

3.—So far, we have shown that the optical electrons can cause the diamagnetism of the atoms, but not their paramagnetism or ferromagnetism. What is then the origin of the latter magnetism? The answer to the question given by the writer is that it is due to the electrons revolving very rapidly in the interior of the nucleus of the atoms.

The atoms consist each of a nucleus and a system of revolving electrons, and the nucleus itself also contains a certain number of revolving electrons, which is nearly equal to the number of the atomic weight diminished by the atomic number. The existence of these innermost electrons is confirmed by the radioactive phenomena; thus the β-ray accompanying the radioactive disintegration is nothing but the electrons projected from the nucleus, the velocity of these electrons being extremely large, and approaching that of light. These swiftest electrons, according to Rutherford, are also revolving in an extremely small orbit within the nucleus, and are constrained by a number of protons to revolve in the orbit round its centre. Though the radius of these revolving electrons is extremely small, their velocity is very large, so that they can give rise to a magnetic moment of reasonable magnitude. For example, in the case of iron atoms, we may assume

$$r = 5 \times 10^{-13} cm, \quad v = 2 \times 10^{10} cm/sec.,$$
$$e = 1.59 \times 10^{-20}, \quad n = 30;$$

and therefore

$$M = \frac{1}{2} nerv = 2.4 \times 10^{-20}.$$

This value nearly agrees with the observed value 2.06×10^{-20} of the magnetic moment of an iron atom. It is thus evident that the presence of the electrons within the nucleus may explain the magnetic moment of the atom.

It is here to be noted that if the electrons are revolving with such a high velocity, the angular momentum of the nucleus is so large that an extremely strong field can only produce a very small turning of the nucleus towards the field, as the theory of the gyroscope shows, and hence these electrons cannot explain the ferromagnetism. To avoid this difficulty, it is assumed, with Rutherford, that just outside these revolving electrons, but still within the nucleus, a certain number of protons are revolving in a circular orbit, but in the opposite direction, and hence the resultant angular momentum due to the protons and to the electrons nearly cancels each other. As the result of the action of a magnetic field, such an atom tends to turn towards the field, this movement being analogous to the motion of the circuit of a metallic wire carrying an electric current; that is, it behaves like a ferromagnetic atom.

4.—Solids are generally crystals or crystalline substances, and the atoms constituting them are distributed along the space-lattice, and execute thermal motions, the amplitude of which increases with the rise of temperature. In the case of ferromagnetic substances, it is assumed that owing to the spherical shape of the atoms constituting them, the effect of thermal impacts among the atoms themselves on their orientation, that is, on their rotational vibration, is, at an ordinary temperature, very small. Since these atoms have each a magnetic moment, they form an immense number of elementary groups, in each of which the magnetic axes, by virtue of their mutual action, take the orientation corresponding to the minimum potential energy, that is, their magnetic axes take one of the directions of the space-lattice; but this direction differs from one group to the other, its distribution as a whole being uniform in all directions, so that when no external field acts on the substance, the magnetic moment vanishes. On the other hand, in the case of paramagnetic or diamagnetic substances, the thermal effect on the orientation of the atoms is assumed to be so great that at any instant, the distribution of the magnetic axes of these atoms is, as a whole, uniform in all directions, unlike that which occurs in the above case of the ferromagnetic substances.

As remarked above, in the case of ferromagnetic substances, both the resultant angular momentum of the nucleus and the thermal effect are very small or zero, and hence, under the action of the field, the atoms will easily turn in the direction of the field against their mutual action, thus giving rise to the ferromagnetic phenomenon. This theory is therefore reduced to Ewing's molecular theory of magnetism. In the case of paramagnetic substances, it is assumed that the resultant angular momentum of the nucleus of the atoms has a fairly great value, and hence under the action of the magnetic field, its gyrostatic effect combined with the thermal agitation will strongly prevent the atoms from turning in the direction of the field. In the case of the diamagnetic substance, the nucleus may have a magnetic moment of considerable magnitude or a very small one; in the former case, the annihilation of the angular momentum within the nucleus is assumed to be very incomplete and hence its gyrostatic effect is so large that the nucleus cannot be deflected by the application of a strong field towards the field in any measurable degree. On the other hand, the outer or optical electrons will make the Larmor precession, thus giving rise to the diamagnetism, as remarked in the foregoing section. In other words, even the diamagnetic atoms may have a definite magnetic moment comparable to that of iron atoms, but owing to their great angular momentum, it cannot be magnetised appreciably; on the other hand, the optical electrons give rise to the diamagnetism.

In short, the nuclei of atoms of all elements have each a magnetic moment, which is determined by the number of revolving electrons in the nucleus and their velocity, and the magnitude of their magnetic moments very probably varies in accordance with Mendeleeff's periodic system. In the ferromagnetic atom, the annihilation of the angular momenta in the nucleus due to the electrons and the protons is almost complete; in the paramagnetic substance, it may be incomplete, the resultant angular momentum having a definite value; in the case of the diamagnetic atom, the value of this angular momentum is extremely great, and hence the substance cannot be magnetised, or the magnetic moment of the nucleus is very small, in either case, the diamagnetism being produced by optical electrons.

5.—In the above explanation, we have considered the origin of the paramagnetism to be in the nuclear electrons, the angular momentum of the nucleus acting as a resistance to magnetisation. In the case of actual magnetisation, the temperature also has the same effect as the angular momentum of the nucleus, that is, the temperature affords a resistance to the turning of the nucleus caused by the magnetic field. The question how much the magnetisation is affected by temperature, was first solved statistically by P. Langevin (*Ann. d. Chem. et Phys.*, 1905 (8), 5, 70), in the case of a diatomic gas. He assumed that all the molecules of the gas have each a constant magnetic moment, and when acted on by a magnetic field, their magnetic axes tend to turn in the direction of the field, but are prevented from doing so by thermal impacts among themselves, and that the distribution law for the direction of these magnetic molecules is given by

$$dn = Ke\ \exp(MH \cos \alpha / rT).dS,$$
$$dS = 2\pi \sin \alpha\ d\alpha$$

where H and M are the magnetic field and the moment of the molecule, respectively, α is the angle between them, r the gas constant referred to one molecule, T the absolute temperature, and K a constant; dn is the the number of molecules whose magnetic axes fall between two cones having vertical angles α and $\alpha + d\alpha$. After some calculation, he obtained the following well-known expression for the intensity of magnetisation I :—

$$I = J^2H/3rNT, \text{ or } k = J^2/3rNT,$$

where J* is the saturation value of magnetisation and N the number of molecules per unit volume. This gives the relation between the intensity of magnetisation or the magnetic susceptibility and the temperature.

If we assume each of the magnetic molecules above referred to to possess a kinetic energy rT of rotation, and consider the magnetisation of the gas by applying the theory of the gyroscope (K. Honda, MAGNETIC PROPERTIES OF MATTER, 1928, 178), we obtain exactly the same expression as before. Hence it is to be concluded that to assume Langevin's distribution function for each molecule is equavilent to giving the moleculs a rotation round its magnetic axis with an energy rT.

6.—In a solid substance, atoms are distributed along the space-lattice characteristic of the substance and exert a mutual action upon each other; when acted on by an external field, this mutual action will prevent the atoms from turning in the direction of the field. Hence the effect of taking this action into account, statistically, is equivalent to an increase of the kinetic energy denoted by ϕ.

Again, though the atoms of the solid substance cannot make a free rotation, the occurrence of rotational vibration about their magnetic axes due to thermal agitation is very probable. At an ordinary temperature, the amplitude of this vibration, and therefore its energy, are generally assumed to be small as compared with that of the free rotation, but to increase rapidly with the rise of temperature by virtue of vivid thermal agitation of atoms at high temperatures. This energy of rotational vibration may generally be denoted by srT, s being a small fraction depending on the nature or the form of the atoms.

Hence if the energy corresponding to the resultant angular momentum of the nucleus be denoted by Q, the total energy affecting the orientation of the atom will be $srT + Q + \phi$. Hence according to Langevin's statistical theory, we may, in the case of a solid paramagnetic substance, put

$$dn = K \exp (MH \cos \alpha / srT + Q + \phi).dS.$$

Hence by a similar calculation as in the case of the gas, we obtain

$$I = J^2H/3N(srT + Q + \phi),$$
or
$$x = J^2/3N(srT + Q + \phi).$$

Q is usually very large and independent of temperature and ϕ is constant or slightly diminishes with the rise of temperature. Hence the above expression may be written in the form

$$x(T + \Delta) = \text{const.},$$

where Δ is constant or very little dependent on temperature. This is a well-known relation and is confirmed by many experiments.

For some substances, srT may be very small; then, neglecting the first term, we get

$$x = J^2/3N(Q + \phi).$$

Here the susceptibility is almost independent of temperature, or slightly increases

---

* I_0, in the original, cannot conveniently be written squared without getting a new *matrix*, so J will be used instead. Elsewhere, Chi (χ) will appear as an ordinary italic x. Also alpha (α) sometimes appears as an italic a.

with the rise of temperature by virtue of ϕ. This case is often actually met with.

7.—P. Langevin first developed the electron theory of diamagnetism (*Ann. d. Chim. et. Phys.*, *loc. cit.*) and obtained an expression for it. Without following his method of calculation, let us consider the case of a single electron revolving in a circular orbit. As has already been shown in the first section, when a magnetic field H acts on it, the Larmor precession gives rise to a diamagnetic moment of the magnitude :

$$\Delta M = -(e^2r^2/4m)(\cos^2\theta+\tfrac{1}{2}\sin^2\theta)H.$$

If the number of revolving electrons contained in a unit volume, whose magnetic axes make with the direction of the field an angle lying between θ and $\theta+d\theta$, be dn, then the intensity of diamagnetism will be

$$dI = -(e^2r^2/4m)(\cos^2\theta+\tfrac{1}{2}\sin^2\theta)H\,dn.$$

Hence, integrating, we get

$$I = -(nm/6)(e/m)^2r^2H,$$

or

$$x = -(nm/6)(e/m)^2r^2.$$

If in each atom several electrons with different radii or orbits be present, we have

$$x = -(nm/6)(e/m)^2\Sigma r^2,$$

where Σ is to be extended to different orbits in an atom.

As is shown above, the diamagnetism is caused by the outer or optical electrons, and therefore the effect must also exist in the case of the magnetisation of a paramagnetic (or ferromagnetic) substance, though the former is in general small compared with the latter. Hence in the general case, we have for the magnetic susceptibility of a given substance

$$x = (J^2/3N(srT+Q+\phi) - (nm/6)(e/m)^2\Sigma r^2.$$

If x_p and x_d denote respectively the para- and diamagnetic susceptibilities, we have

$$x = x_p - x_d.$$

Thus the actually observable susceptibility x is the difference between x_p and x_d; x may be positive or negative, according as x_p is greater or less than x_d. In either case, the atom may have a definite magnetic moment.

Since the Langevin diamagnetism depends only on the orbital motions of the outer electrons, it is hardly influenced by temperature, while the diamagnetism actually observable, being the difference between the para- and diamagnetisms, may sometimes vary with temperature by virtue of the paramagnetic term. Thus the observed decrease of diamagnetism in many chemical elements with the rise of temperature is probably due to the increasing paramagnetism, which is caused by a gradual decrease of mutual action among atoms, as the temperature is raised.

8.—Consider next the change of magnetic susceptibility during an allotropic change or of melting. In the first term x_p, J and Q are both constants characteristic of the nucleus of the atom and therefore do not vary at all during these changes; but in the case of an allotropic change, s and ϕ may vary more or less, both increasing as the contraction of volume is accompanied, and decreasing in the opposite case. In the case of melting, s always increases and ϕ decreases to zero, so that $sNT+\phi$ may increase or decrease, but in most cases this difference will probably be positive.

As regards the diamagnetic term x_d, all the quantities except Σr^2 do not change with the transformation or the melting. In solids, the diameter of the orbital motion of electrons is comparable to the spacing of the lattice, and hence when this diameter approaches or is greater than the spacing, some of the electrons in the outermost ring may be deflected by neighbouring atoms from their own orbit and may stray as free electrons among the atoms, these electrons thus playing the principal *rôle* in the conduction of electricity. This ingenious idea is due to K. Höjendahl and J. F. Frenkel (K. Höjendahl, *Phil. Mag*, 1924, 48, 349; J. Frenkel, *Zeits Phys.*, 1924, 29, 214). Accordingly, when during an allotropic change or the melting, a contraction of volume takes place, free electrons increase at the cost of bound electrons; but when an expansion of volume takes place, the contrary is the case. In the former case, Σr^2 or the Langevin diamagnetism must decrease and at the same time the electrical conductivity increase, and in the latter case, the diamagnetism must increase and the conductivity decrease.

In order to compare these conclusions with the results of observations, consider first the case of paramagnetic substances, in which the second diamagnetic term can be neglected. It is well known that iron possesses two allotropic transformations at 910° and 1400°; the former change is called the A_3 transformation and the latter the A_4 transformation. A volume contraction and a decrease of the paramagnetic susceptibility accompany the first transformation, and a volume expansion and an increase of susceptibility are associated with the second. These facts agree with the conclusions from our theory; for, with the volume contraction, s will increase owing to the greater chance of thermal impacts. With

regard to the electrical resistance, Burges and Kelberg (*Jour. of Washington Acad.*, 1914, 5, No. 15, 435) found the decrease of resistance during the transformation in accordance with the above conclusion. The change of resistance at the A_4 point has not yet been determined, but, from the theoretical point of view, it is an increase.

Consider next the case of the diamagnetic susceptibility, in which the first paramagnetic term may be taken as negligibly small. Thallium is diamagnetic and undergoes an allotropic change at 225°, accompanied by a volume contraction; hence the diamagnetic susceptibility and the electrical resistance should numerically diminish. This conclusion agrees with the results of observation. Grey tin is also transformed into white tin at 18°, being also accompanied by a great contraction and a marked diminution of diamagnetism.

Lastly, consider the case of melting. During melting the volume of chemical elements, with the exception of bismuth and antimony, generally increases. Hence the paramagnetic susceptibility should generally decrease during melting, as $srT+\phi$ will generally increase during the same change; this conclusion is borne out by experiment. In most of the diamagnetic elements, the diamagnetic susceptibility slightly decreases as the result of the opposite changes in the two terms x_p and x_d, but in a few cases, such as gold and silver, it increases during melting. In these elements the electrical resistance is increased by melting, as the result of the diminution of free electrons due to the volume expansion during melting. In the case of bismuth and antimony, the volume contraction takes place during melting, and therefore the electrical resistance considerably decreases owing to the increase of free electrons. From the same cause, the diamagnetic susceptibility of the two metals must decrease during melting, as is actually observed.

In the susceptibility-atomic-number curve for chemical elements obtained by the present writer (K. Honda, MAGNETIC PROPERTIES OF MATTER, 1928, 130), the paramagnetic and diamagnetic susceptibilities of elements form a continuous curve in crossing the zero line, notwithstanding the fact that the origins of these two kinds of magnetism are quite different from each other. This peculiar fact is easily realised from the expression $x = x_p - x_d$, no further explanation being necessary.

The fact that a diamagnetic compound is formed by two paramagnetic atoms, and that a paramagnetic compound is formed by two diamagnetic atoms, may also be explained by our theory. For, according to the theory, the magnetic moment of the diamagnetic atoms may have a definite value, their angular momentum being assumed to be very great, but in the formation of the molecule from these atoms, it may result that by the mutual configuration of them, the angular momentum as a whole greatly diminishes in magnitude, so that the behaviour of the molecules is now paramagnetic. On the other hand, the angular momentum of paramagnetic atoms is not so great as in the case of diamagnetic atoms, but the formation of the molecule from these atoms may increase the same quantity as a whole and so result in a diamagnetic molecule.

A similar explanation also applies to the formation of a ferromagnetic substance from para- or diamagnetic elements. When two or more atoms, the nuclei of which each possess a magnetic moment and an angular momentum of great magnitude, combine to form a molecule, the resultant angular momentum of the nuclear system may happen to be very small; then the resultant substance will be ferromagnetic.

In the case of solid ferromagnetic substances, the magnetisation causes the turning of the nuclei towards the direction of the field, and when the field is very strong, all the nuclear magnets point in the direction of the field. But the outer or optical electrons will make the Larmor precession, though this will not be so free as in the case of the single atom, and some electrons may be prevented from doing so by the influence of the neighbouring atoms. At any rate, during magnetisation, any appreciable polarisation of the orbital plane of the optical electrons cannot be produced. This explains the remarkable fact that the scattering of the X-rays from iron is not in the least affected by the application of a very strong field.

So far the above theory of magnetism explains very satisfactorily many observed facts as regards ferromagnetism, paramagnetism, and diamagnetism, and may be considered as the most complete among those hitherto proposed.

ON THE TOWER SYSTEM IN THE MANUFACTURE OF SULPHURIC ACID. I.

By TOMONOSUKE SAKAMAKI.

The author calculated the change ratio of SO_2 and the coefficient of radiation in every tower from the acid made and those were as follows :—

No. of Tower.	1	2	3	4
Coeff. of radiation K cals./°C.h.qm.	5.03	6.15	5.78	5.39
Change ratio of SO_2 in %	25.28	32.36	34.46	7.9

From this table, the coefficient of radiation in the tower might be considered as about 5 K Cals./°C.h.qm as that in the lead chamber, too.

In the operation there might be no better way to regulate the amount of the acid irrigated into the tower as well as the nitre circulation scientifically. Using V notch, piano box, etc., the author could succeed in finding the optimum condition concerned with the amount of the acid as well as nitre circulating between the towers.

The author criticised the operation method in Hruschau factory against his method.

CAMPHOR.

While the camphor industry in Japan has a long history, since its start in 1908 in Kagoshima prefecture, its rapid development has been recorded in Formosa, where an abundant source of camphor tree was found, and which became the territory of Japan. The production of camphor in 1926 was estimated at about 2,847,000 kins (1 kin = 0.6 kgr.), together with 11,616,000 kins of camphor oil. The situation of the industry however seems to be threatened by the success of the industrial production of the synthetic camphor in Germany, and every means which serves to cut down the production cost is now seriously investigated. The increase of the plantation of camphor tree, the improvement of the distillation plant using the material profitably, and the utilisation of camphor oil, which contains many valuable compounds such as pinene, limonene, turpinol, safrol, eugenol and others, as the starting material for the preparation of valuable essential oils, are studied by many investigators of the respective lines. The utilisation of camphor oil is considered to be most promising, for if it succeeded profitably the cost of camphor can be reduced so that it can compete with the synthetic camphor. The synthesis of camphor, however, is by no means neglected.

On the other hand, however, the studies of the camphor tree are also carried out. According to the report of S. Sakai, the content of camphor and camphor oil in the tree are as follows :—

TABLE I.

Circumference of tree trunk at the height of about 2m.	Amount of camphor substance		Amount of camphor substance content in one tree	
	Camphor	Camphor oil	Camphor	Camphor oil
m.	%	%	kin	kin
0.33	0.01	1.20	0.04	0.42
0.66	0.30	1.60	1.30	4.28
0.99	0.65	1.80	5.47	12.84
1.33	1.15	1.70	18.03	25.15
1.66	1.42	1.60	38.92	42.28
3.33	2.86	1.15	454.24	182.18
Branches and leaves	1.10	0.33	—	—

TABLE 2.

Camphor content in various parts of tree 20 years old.

Parts	Contents of camphor tree %	
	Camphor	Camphor oil
Branches	0.18	0.50
Central trunk	0.60	0.93
Trunk at ground level	0.79	1.92
Massive root	0.98	2.36
Branch roots	0.14	2.58

Recently Mr. T. Yahagi has investigated the origin of camphor in camphor tree (*Cinnamomum camphora*, Nees. et Ebe.) by an extensive cytological and morphological studies of the tissues obtained from various parts of trees, arriving at many important conclusions. He has ascertained that certain enzyme matter of the nature of a peroxidase exists in the oil cells of camphor trees, and the formation of camphor products is chiefly due to its direct action on the substance of the cells. The formation of camphor and the oil is more active

where the vegetation is stronger. Once the formation of the oily matter is started within the cell, it proceeds fairly rapidly within it, until it is finally filled with camphor products. The formation of camphor and the oil takes place in the very early stages in the growth of the plant, and the course of the formation of the oily matter in the cells is traced up in nearly all parts of the tree tissues of active growth. Especially it is very distinctly observed in the tissues of the wood lying beneath the cambial layer. The sap of camphor tree contains no perceptible amount of camphor, which disproves the theory that the oils in general are formed by the secrete organs, being held in solution in the juice which circulates through the tissues of the plants. The so-called resinogenous layer which is claimed to exist along the inside wall of oil cells seems to correspond to the layer of peroxidase. The lining of peroxidase is found to exist n the cells of the tissues of *Cinnamomum loureri*, Nees., *Laurus nobilis*, L, and few others beside camphor trees.

K. Atsuki.

(*Japanese Soc. of Chem. Industry.*)

STEEL FOR CASEHARDENING—NORMAL AND ABNORMAL STEEL.

By S. Epstein and H. S. Rawdon.

(*U.S. Bureau of Standards.*)

That soft spots in casehardened articles may be due to the kind of steel used, as claimed by McQuaid and Ehn, has been experimentally confirmed. The characteristics of the so-called normal and abnormal microstructures of the extreme types and intermediate gradations are described. On quenching in water structurally abnormal steel proved more prone to give soft spots. However, by quenching in brine or other drastic quenching media uniformly hard cases were obtained in structurally abnormal steel as well as in normal steel. Air or other gases which are usually dissolved in quenching water may cause soft spots. After carburising, the core of abnormal steel, most probably because of its finer grain, had higher impact strength than normal steel. Most cases of abnormality in commercial steel seem to be associated with the use of aluminium for deoxidising, although abnormal steel can also be produced in other ways. Nothing arose during the progress of the investigation to disprove Ehn's theory that abnormality is ordinarily chiefly due to the presence of oxides, perhaps dissolved but more probably undissolved.

GENERAL NOTES.

OIL FROM COAL.

A bright future for oils from coal and for gas companies who put into operation the low temperature method of carbonisation was predicted by Lieut.-Colonel W. A. Bristow, the managing director, and a well-known fuel expert, at the annual meeting of the shareholders of Low Temperature Carbonisation, Ltd., in London on Monday, November 19.

Colonel Bristow said that, but for the temporary shortage of capital in the coal industry, he would have been in a position to announce the conclusion of contracts for the erection of low temperature carbonisation plant for the manufacture of coalite and the recovery of coal oils at the pit-heads of several collieries. There was now evidence that the temporary embarrassment was passing, and he would not be surprised if, before long, they were in a position to state that some of the largest collieries were taking up the system.

Referring to the fact that the South Metropolitan Gas Company had taken up a licence to produce coalite and coal oils by the British Parker method of low temperature carbonisation, Colonel Bristow said that gas companies would undoubtedly be able to make an even larger gross profit than was made by the parent company, inasmuch as they could recover thirty therms of rich gas per ton of coal carbonised, for which they would receive from the public 15s. In addition, they had an immediate market for the smokeless fuel. "Any gas company," he said, "that applies this method of dealing with coal will undoubtedly make a very considerable change in its financial prospects."

"The position in regard to oil has considerably improved during the past year," continued Colonel Bristow. "Since new low temperature carbonisation plant was started at Barugh, we have made 5,850,000 gallons of crude oil, and produced 160,000 gallons of motor spirit. Under the last Budget, provision was made for a rebate of 4d. a gallon, or £5 per ton, upon all motor fuel produced from home-made oils. Naturally, we have not had time to take full advantage of this revolutionary improvement in the oil business, but we are doing so as rapidly as we can. Our present plant for recovering petrol from the oils is being replaced by the most modern petrol plant in the country, and our revenue from this source will be doubled as soon as this comes into operation."

Colonel Bristow pointed out that it had been impossible to crack all the oils recovered, but had they done so, they would have produced—taking into account the additional amount of spirit recovered from the gas—no less than 630,000 gallons of petrol. That was on the basis of recovering 30 per cent. spirit. The total amount of preferential rebate on this quantity of petrol was equivalent to £10,560, in addition to the normal profit, or, in other words, a bonus of over 20,000 tons of coal, taking the price of coal at the pit-head as 9s.

"We are now co-operating with research workers in Great Britain, America and the Continent in connection with the fractionating of low temperature oils," he added. "We are progressing rapidly, and I think before long we shall be able to establish a national system of dealing with these oils from all the low temperature plants, which will give us a very much larger yield than anything we have been able to obtain hitherto. It is extremely satisfactory to know that the oil itself is inherently good. There is no need to apologise for the petrol we are making because it is made from coal. It is superior to any petrol sold in this country as No. 1, and we have an independent report from people in America who are concerned in the manufacture of high-grade petrol to the effect that, in their opinion, this petrol is exactly the same as their very special class for which they receive top price."

Sir Arthur Wheeler, Bart., Chairman of the Company, in moving the adoption of the annual report, referred to the extraordinary progress now being made by low temperature carbonisation. "In every part of the country," he said, "responsible opinion in the medical, municipal and fuel worlds is acclaiming the triumph of low temperature carbonisation in producing a solid, smokeless fuel capable of helping materially in the solution of the smoke problem."

Councillor Will Melland, of Manchester, Chairman of theSmoke Abatement League of Great Britain, specially attended the meeting as a non-shareholder in order to say how the League, which was out for the purification of the admosphere, admired the splendid pioneer work that the Company had achieved in producing domestic smokeless fuel. They wished it the greatest success in the future.

The Underfeed Stoker Co., Ltd., announce that they have entered into arrangements with Combustion Engineering Corporation of New York and the Societe Anonyme des Foyers Automatiques of France whereby they are licensed to sell the new "L" type travelling grate stoker.

It is now generally well known that the special features of this machine enable efficient combustion results to be obtained from the smallest and lowest grades of fuel, and several very successful installations have been put into operation in this country for the burning of coke breeze.

NON-METALLIC MINERAL INDUSTRIES IN WESTERN CANADA.

The Canadian Mining and Metallurgical Bulletin in its November issue contains a paper prepared by Mr. H. B. Lumsden, Assistant Director of Development, Canadian Pacific Railway Company, on "The Development of Certain Non-Metallic Minerals in Western Canada."

HUGE BED OF SALT FOUND IN ALBERTA.

According to an announcement made by the Minister of Railways and Telephones of Alberta, drilling operations carried out at Waterways, a point at the northern terminal of the Alberta and Great Waterways Railway, have revealed a large bed of salt. The salt was struck at the 670-foot level, and as the drilling has now reached the 883-foot level and is still encountering the salt deposit, it means that there is a solid vein at least 213 feet in depth.

NEW NATURAL GAS DISCOVERY IN WESTERN CANADA.

A tremendous flow of natural gas struck in the Meridian No. 1 well about 22 miles south of Lloydminster, Saskatchewan, marks the discovery of a new natural gas field in Western Canada. The well is located about three or four miles over the boundary in the province of Alberta, and is in what is known as the Ribstone Creek field in which drilling was being carried on for oil following the publication of a report on the structure by Dr. G. S. Hume, of the Dominion Geological Survey.

The strike of gas was made on October 30, and the well burst forth with a terrific explosion. Preliminary indications are that it is blowing off at the rate of about 30 million cubic feet of gas daily. Mr. Charles Dingman, an Oil Engineer in the service of the Dominion Hepartment of the Interior, has proceeded to Lloydminster in order to examine the well with the object of discovering whether it is likely to be an oil producer.

THE NATIONAL MUSEUM OF CANADA.

The Dominion Department of Mines at Ottawa has just published National Museum Bulletin No. 50 containing the Annual Report of the National Museum of Canada for 1926, copies of which can be obtained by persons interested on application either to the Department itself at Ottawa or to the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

In the Bulletin is printed an article by Dr. W. H. Collins, Acting-Director on the "General Activities of the Museum, describing the course of Museum Lectures, Conversaziones and other activities carried on by the staff; and there is also a more detailed article by Dr. W. H. Collins on the history of the Museum going back to the foundation of the Geological Survey as long back as January, 1832.

MINING METHODS AT BRITANNIA, BRITISH COLUMBIA.

The Canadian Mining and Metallurgical Bulletin in its November issue contains the paper by Mr. J. I. Moore, Jun., on "Mining Methods at Britannia, B.C.," preparer for the Annual Meeting of the British Columbia Section of the Canadian Institute of Mining and Metallurgy held at Vancouver on November 22.

This issue also contains a paper prepared by Mr. F. Ebbutt, entitled "The Precipitation of Copper from Mine Waters at Britannia Mines, B.C."

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.

The Treasury have made an Order under Section 10 (5) of the Finance Act, 1926, exempting the following articles from Key Industry duty from 1 December, 1928, to 31st December, 1929 :—

Celtium oxide, Chinosol, Dicyandiamide, Dysprosium oxide, Erbium oxide, Europium oxide, Gadolinium oxide, Holmium oxide, Lutecium oxide, Samarium oxide, Terbium oxide, Thulium oxide, Ytterbium oxide.

This Order also continues till 31 December, 1929, the exemption from duty of :—

Acid hydrocyanic anhydrous, Acid lactic which satisfies the requirements of the British Pharmacopœia, Acid oxalic, Amidopyrin (Pyramidon; Dimethyl-amidoantipyrine), Ammonium perchlorate, Barbitone (Veronal; Malonal; Malourea; Acid diethyl barbituric; Diethylmalonylurea; Hypnogen; Deba). Bromural (Dormigene). Cocaine crude, Dial (Acid diallyl barbituric), Didial (Ethyl morphine diallyl barbiturate), Elbon (Cinnamoyl para oxyphenyl urea), Ethylene bromide, Eukodal, Furfurol, Glycol ethers, Guaiacol carbonate (Duotal), Hydroquinone, Integrators (planimeter type), R. Lead acetate, Lead tetra-ethyl, Lipoiodin, Lithium carbonate, Lithium hydroxide, Metaldehyde, Methyl chloride, Methyl sulphonal (Diethylsulphonemethylethylmethane; Trional), Nickel hydroxide, Papaverine, Phenacetin (Acetparaphenetidine), Phenazone (Antipyrine; Phenyldimethylpyrazolone; Analfiesin; Anodynine; Dimethyl oxychinizin.), Phytin, Piperazine (Diethylene-diamine; Dispermin), Planimeters, R. Potassium chlorate, Potassium guaiacol sulphonate (Thiocol), R. Potassium hydroxide (R. Potassium caustic; R. Potassium hydrate), R. Potassium permanganate, Pyramidon-veronal, Quinine ethyl-carbonate, Resorcine (Resorcinol), Salol (Phenyl salicylate), Styracol (Guaiacol cinnamate), Sulphonal, Synthalin, Urea (Carbamide), Vanadium-silica compounds specially prepared for use as catalysts for sulphuric acid manufacture.

The Treasury Order will shortly be published by the Stationery Office.

PAST AND PRESENT IN CHEMICAL TEACHING.

At the opening meeting of the Manchester and District Branch of the Institute of Chemistry of Great Britain and Ireland, Professor Smithells, President of the Institute, delivered an address.

In the late seventies, he said, and early eighties, which included the period of his studentship, chemistry was, in the opinion of the speaker, in a relatively dull phase of its history, especially on the inorganic side. The old dualism of Berzelius had been superseded by the unitary system, and the influence of organic chemistry was leading to much discussion of valency and the use of constitutional formulæ for inorganic compounds. He had found the inorganic chemistry of his day very lacking in logic and general principles. The chemistry of the day was organic chemistry, and at the time he and his fellow-student Julius Cohen went to Germany, one had the choice of Baeyer, Bunsen, Emil Fischer, Fittig, Hofmann, Kekulé, Kolbe, Landolt, Liebermann, Lothar Meyer, Wislicenus. They had elected to go to Baeyer in Munich and there had in the laboratory as fellow students Duisberg, Bamberger, Curtius, Friedländer, W. H. Perkin, junr., von Richter,

and others, who became leaders in the science.

In compliance with Roscoe's wishes, he (the President) had proceeded from Munich to Heidelberg in order to learn the laboratory methods of Bunsen. Bunsen, then 73, but full of vigour, and in the laboratory every day and most of the day, still presented chemistry in the old dualistic form. He admitted that the Berzelian ideas had been found wanting and had been rightly superseded, but he maintained that for expository purposes, for rationalising the great majority of chemical reactions of inorganic chemistry, the Berzelian theory was still unsurpassed. The speaker said that Bunsen had made good his case and that his lectures as well as his teaching in the laboratory were in the highest degree inspiring and were a revelation of an earlier day when inorganic chemistry had something like a connected philosophy.

Professor Smithells then reviewed in a reminiscent way further marked periods in his experience of chemical teaching, the ionic invasion of 1890, when Van't Hoff and Ostwald came in person to the meeting of the British Association at Leeds; and, lastly, the arrival of the electron and the penetration of the atom.

In the course of his commentary, Professor Smithells took three illustrations, namely, the action of nitric acid on copper, the atmospheric oxidation of a solution of ferrous sulphate, and the formulation of meerchaum, to make clear the changes that had occurred, the formulation being given in terms of :

(1) Berzelian dualism.
(2) Unitary molecular formulæ.
(3) Constitutional formulæ (according to the system of Edward Frankland.)
(4) Ions.
(5) Electrons.

In the course of his remarks he gave an account of the fortunes of chemical analysis in chemical curricula. In his student days at Manchester there was little besides analytical chemistry up to the stage of research. The invasion of the student course, first by practical organic chemistry, secondly by practical physical chemistry, had greatly reduced the analytical teaching which, as a rule, had been of an uninspiring kind after the Berzelian dualism had gone. The new dualism of the ionic theory did much to rationalise analysis for the student and to a good many people seemed to bring the first evidence of the philosophical content and value of enlightened analytical teaching. Professor Smithells fully believed that the revolutionary discoveries of the last few years which had given the electron its sway in chemistry must, in the end, immensely simplify and rationalise the teaching of chemistry. There would, however, be a considerable period to pass through in which both teacher and student would probably find additional embarrassments. The immense accumulation of facts, the great theoretical developments, the innumerable new applications of chemistry and the demand that the chemist shall be equipped with much knowledge outside chemistry, including, in particular, mathematics, presented to the teacher a most serious and difficult problem. It was now a common complaint that the university courses were in many cases much too congested and that far too great a burden was put upon the student, and especially upon his memory. One result of the congestion was that a type and amount of chemistry teaching was being forced upon the schools which many people thought wrong, both for the schools and for the universities. He knew, however, that there was a wide divergence of opinion on this subject among university teachers.

Another complaint frequently heard today was that whilst students were found to be wonderfully learned about more recent developments of chemistry, they were apt to be lacking in simpler knowledge, and especially in relation to that part of the subject still known as inorganic chemistry.

Professor Smithells said he was endeavouring to state facts and to avoid expressing opinions of his own, for he knew how prone elders were to complain of the present, and how much their opinions were attributed to an inability to live up to the times. But, without expressing personal opinions on matters of detail, he was satisfied that the present situation was unsatisfactory and he believed that good might come of a serious conference among those charged with the duty of the professional training of chemists.

In America the subject of chemical education seemed to be becoming a study in itself. He was well aware of a wide distrust in England of the value of conferences, but he did think that good might come of chemical teachers meeting for an exchange of opinion and for determining whether the burden at present put upon students was excessive, and, if so, how it could be reduced. A second question was that of inorganic chemistry, and a third that of the amount of chemical knowledge that should be given in schools.

THE ROYAL MICROSCOPICAL SOCIETY AND ITS LATE SECRETARY.

ACTION BY THE LATTER FOR WRONGFUL DISMISSAL FAILS.

In the London High Court, King's Bench Division, on November 23, before Mr. Justice McCardie and a special jury, the case of Lock *v.* the Royal Microscopical Society was heard and decided. The result was that his Lordship held that the plaintiff had no case in law, and the jury were directed to return a verdict for the defendants.

The action was brought by Mr. Charles Frederick John Lock, of Beaumont House, North End Road, West Kensington, London, W., who claimed damages for alleged wrongful dismisal and defamation of character from the Royal Microscopical Society, of 20, Hanover Square, London, W., of which he had been secretary, and from Dr. James A. Murray, F.R.S., of 8, Queen Square, London, W.C., president, and Mr. Joseph E. Barnard, F.R.S., of Park View, Brondesbury Park, London, N.W., and Dr. Clarence Tierney, of Netherton, Coulsdon, Surrey, joint honorary secretaries of the society.

The plaintiff complained that on May 11, 1927, the defendants (other than the society) falsely and maliciously spoke to each other and to Mr. Akehurst, the honorary librarian, the following words: "The engagement of Mr. Lock as secretary of the society should be terminated." By those words, he said, the defendants meant that he was a person who was unfit to be in the service of the society.

The defence was a plea of privilege, and that the words were spoken (if at all) in pursuance of their duty without malice and in the honest belief that they were true.

Mr. E. S. Cox-Sinclair appeared for the plaintiff; Sir Henry Maddocks, K.C., and Mr. N. L. Macaskie for the defendants.

Mr. Cox-Sinclair, in opening the case, said that the plaintiff had been for nine years secretary of the Royal Microscopical Society and was dismissed from that position in May, 1927. He had had training and long experience as a journalist, and many opportunities of making himself proficient in all kinds of secretarial work. The society employed him as from May 1, 1918, as assistant secretary and librarian at a salary of £250 a year, plus a commission on advertisements in the society's Journal, the engagement being terminable by three months' notice on either side. During his nine years' service the society expanded in its activities and achieved a greater measure of success than before. Down to the date of the plaintiff's dismissal no charge was ever made against him as to the way in which he performed his duties. On the contrary, reiterated expressions of satisfaction with his services were recorded.

On May 11, 1927, Dr. Murray, the president of the society, instructed Mr. Lock to put on the agenda paper for the next meeting of the council a recommendation of the executive that his (the plaintiff's) engagement as secretary should be terminated. It was, said counsel, as if the plaintiff were told to write out his own death warrant. On the following day Mr. Lock wrote to Dr. Murray complaining that he had been given no opportunity of refuting any statements made against him; and the president replied that the decision of the executive was arrived at because of statements made by Mr. Akehurst, with whom the plaintiff had had some trouble about the removal of a safe.

AN ALTERED MINUTE.

On May 18, 1927, the minutes of the council recorded that the recommendation of the executive had been carried, and also an expression of appreciation by the council of the way in which the plaintiff had carried out his duties. At the next meeting of the council the minute was altered to read that the president had expressed his appreciation. The plaintiff received three months' salary in lieu of notice.

Counsel said that what Mr. Lock complained of was that he was not only dismissed, but was told that he was not expected to attend at the office.

His Lordship: What is your case as to wrongful dismissal?

Mr. Cox-Sinclair: The plaintiff did not receive notice within the terms of his agreement. He was dismissed summarily, although he was paid three months' salary.

His Lordship: He got his notice and salary for three months, but was not called on to do work for the last two months?—Yes.

He is not bringing his action because he was not allowed to work?—No, but because the employment was terminated when it was.

The plaintiff, giving evidence, said that he was experienced in secretarial work and accountancy. After his nine years' service with the defendant society he was told that the executive officers had decided that there should be a change in the secretaryship. His complaint was against the insidious suggestion that there was something inexplicable

which rendered him unfit to hold any longer his position as secretary.

His Lordship: You really bring this action to show that there was nothing against your character and work. Is that your object?—One of them.

What is the other? You are asking for damages?—Yes.

What for?—Because, under the present condition of things, when I apply for another post I receive a printed form asking me to state the reason for my leaving my last employment, and I cannot do it. This method of dismissing me has prevented me from obtaining any other employment.

His Lordship: That is a misfortune which marks the social and labour world to-day. No employer is bound to give a character to anyone who has left his service. If he does give a character, of course, it ought to be an honest one.

Sir Henry Maddocks: We have never been asked for one.

His Lordship (to the plaintiff): You have never asked the society for a testimonial?—I was offered a particularly good testimonial if, instead of putting in the minutes that I had been dismissed, I would say that I had tendered my resignation, which had been accepted. I would not be a party to anything of that sort.

What is your age?—Sixty-seven years.

Do you think you could get a position elsewhere if you received some appreciative letter from the society?—Yes.

Have you no idea what the reasons were which led the society to dispense with your services?—It seems to be the personal dislike of Dr. Murray, the president.

A Circular Alleged to be Libellous.

The plaintiff went on to say that a Dr. Ludford had on one occasion brought him a circular and had asked him to send it out. He came to the conclusion that it was libellous and that it would be dangerous to issue it. Dr. Murray then said that as president he instructed him to issue it; but he still declined to do so without definite instructions from the council. The effect of his refusal was that it caused strained relations between him and the president. The council afterwards decided to issue the circular, but at the next meeting it was withdrawn, and Dr. Murray apologised for the way in which it had been sent out.

Sir Henry Maddocks said that the society had no desire to do the plaintiff any harm, but simply desired a change of secretary.

Mr. Cox-Sinclair: On the minute book, as it stands, is the withdrawal of the appreciation of the society and the substitution of the personal appreciation of the president. If the society would say now that there is nothing against his character as servant of the society, the matter would be entirely different. Would my friend state what could be said?

Sir Henry Maddocks did not reply.

The plaintiff said that he knew of nothing that would warrant the society's dismissing him. Dr. Murray came into the office one day when Dr. Tierney was there and complained that when he instructed him (the plaintiff) to send out the Ludford memorandum he had refused to do so without instructions from the council and yet he had issued a memorandum for a Dr. Eyre. He (Mr. Lock) replied that the latter circular did not contain libellous matter as the other did. There was also the question about the removal of a safe.

His Lordship: These small incidents seem very appropriate to the fact that the defendants are the Royal Microscopical Society. We all have our differences of opinion, and life would not go on if men magnified these microscopical things.

Sir Henry Maddocks stated that he had no questions to ask the plaintiff.

Mr. Cox-Sinclair said that that concluded the plaintiff's case.

Sir Henry Maddocks submitted that there was no case for him to answer.

After some discussion, his Lordship told the jury that the plaintiff had no case in law, and he directed them to return a verdict for the defendants, which they did.

Sir Henry Maddocks said that he did not ask for the usual costs, but that they should be limited to out-of-pocket payments by the defendants.

Judgment was entered for the defendants accordingly.

CORRESPONDENCE.

(*To the Editor of the* Chemical News.)

Sir,—It would be a disservice to the cause of coal reform if the rather slighting reference to low temperature carbonisation made by Mr. E. D. Simon in his paper on "Housing" at the Public Health Congress were allowed to pass unchallenged. Mr. Simon said that many people were 'optimistic enough" to think that low temperature coke would at some time be available

as an adequate alternative to raw coal for the open grate, and later he remarked :—" There is, of course, always the possibility of a cheap smokeless fuel that can be burned in the open grate. Personally, I am very doubtful whether this will ever appear, nor do I think it essential."

Such a declaration comes at a particularly unfortunate moment for Mr. Simon, for there is evidence on all sides that the public demand for low temperature smokeless fuels is so great that existing low temperature plants are insufficient to deal with it. This demand has been largely brought about by the official encouragement to the burning of such fuels now being given by smoke abatement organisations, Medical Officers of Health, hospital anthorities, and others. The West Riding of Yorkshire Smoke Abatement Committee, after investigating the production of smokeless fuel in Yorkshire by low temperature carbonisation, took active steps to foster its use for domestic purposes in its own area. The Smoke Abatement League of Great Britain went so far as to institute a widespread enquiry among users, and their report, which strongly recommended local authorities to do everything in their power to encourage the use of such fuels, constitutes one of the greatest contributions towards the solution of our smoke problem.

Never was the time more favourable for colliery companies, gas undertakings and municipalities to exploit by the low temperature carbonisation method the almost unlimited market for domestic smokeless fuel capable of burning in the open grate.

The smoke problem is so vast that there is ample room for all remedial agencies—gas, electricity, and low temperature smokeless fuels. The sooner the old rivalries are sunk and the publis is encouraged to use every effective alternative to raw coal, the better it will be for the cause of atmospheric purity and the general prosperity of the fuel industries.

I am, Sir,

Yours, etc.,

R. G. L. ANDERSON,
Chairman,

West Riding of Yorkshire Regional Smoke Abatement Committee.

" The Close,"
Sandal, Wakefield.
29th November, 1928.

NOTICES OF BOOKS.

Scent and All About It. By H. STANLEY REDGROVE, B.Sc., A.I.C. London : Messrs. Heinemann (Medical Books) Ltd. Price 3s. 6d.

Perfumery may lay claim to be one of the most interesting branches of organic chemistry, yet it is remarkable how very few books there are dealing with the subject in the English language. The needs of chemists working in the industry are indeed admirably met by the treatises of Parry, Poucher and others. We were, however, not thinking of these, but of the ordinary chemist and of the general reader who, considering the enormous quantities of perfumes used nowadays, may be expected to be curious as to their composition and manufacture. In French there are several books giving a bird'e-eye view of the subject, but we cannot recall to mind a single book in English, at once popular in style and accurate, which covers the whole ground.

For this reason we accord a very hearty welcome to *Scent and All About It.* It is some little time since we have had the pleasure of welcoming a book from the pen of Mr. Redgrove, an old contributor to the *Chemical News*, and we are glad to know that other works on cognate subjects are in course of preparation by him, for he possessses in a marked degree a facility for making abstruse matters—and the chemistry of perfumes is abstruse—plain to the mind of the man in the street.

Scent and All About It admirably fulfils all the requirements indicated in our opening paragraph. In the preliminary chapters, Mr. Redgrove rapidly surveys the history of the subject, and deals in a most interesting manner with the physiology and psychology of perfumes and the classification of odours, special prominence being given to the method of classification devised by Rimmel. A special chapter deals with alcohol. There follows an account of the animal substances used in perfumery, ambergris, musk, civet, etc., four chapters devoted to the essential oils and other perfume materials obtained from plants, all the processes of extraction being interestingly described; and three chapters dealing with the enormous contributions chemistry has made to perfumery, details being given concerning the manufacture and uses of the chief synthetic products utilised in the art. Then there are a couple of chapters describing the preparation of finished perfumes, a number of useful formulæ being given, whereby the reader is enabled to try

his hand at making perfumes at home if he so desires.

The book contains an index and a very complete bibliography, the whole forming a very attractive and informative volume, which should be in the library of every chemist. So far as the general reader is concerned, the volume should prove a very acceptable gift-book, at this season of the year, to the user of perfumes. Nowadays we are all users of perfumes, in one way or another, though we are not always conscious of the big debt our noses, which are always being pleased with delicious odours, owe to the science of Chemistry—a debt which Mr. Redgrove has made abundantly clear.

Gases and Liquids. By J. S. HALDANE, F.R.S. Pp. xvi + 334. Published by Messrs. Oliver and Boyd, 33, Paternoster Row, E.C., and Tweedale Court, Edinburgh. 1928. Price 18s.

Prof. Haldane's contribution to the study of molecular physics has been to examine critically and restate the general physical laws as applied to gases and liquids. This has meant, in some cases, a break away from from certain existing academic ideas and indeed the author has adversely criticised some of the reasoning of such distinguished scientists as van't Hoff, van der Waals, Carnot and Lord Kelvin.

Prof. Haldane has attempted to develop the conception of "molecular Physics," as advanced by Waterston about 1845. Waterston's views remained unpublished in the Archives of the Royal Society, where the late Lord Rayleigh found them. Now Prof. Haldane has prepared simultaneously with this volume, *The Collected Scientific Papers of J. J. Waterson* (Oliver and Boyd).

From studying the data concerning osmotic pressure (Prof. Haldane is primarily a physiologist) he has been led to modify his ideas concerning the connections between the states of matter and has re-interpreted, for instance, van der Waals' equation and its applications. The author also points out that despite extensive investigations the efficiency with which engines convert heat energy into mechanical energy is exceeedingly low. The great practical importance of applying correct scientific principles in the design and use of engines is obvious and the examination of Prof. Haldane's volume, should at least stimulate further enquiries which may lead to improvements in the desired directions.

Molecular Rearrangements. By PROF. C. W. PORTER. Pp. 167. New York: Chemical Catalog Co. 1928. Price, $4.

In this volume of the American Chemical Society's Monographs, Prof. Porter has described and attempted to explain the mechanism of many classes of molecular rearrangements although he excludes tautomeric changes and intramolecular neutralisations as he considers a typical re-arrangement is an irreversible process.

Most of these re-arrangements follow the unimolecular law but in some instances the actual mechanism of the change must be bi-molecular.

The phenomenon is comparatively rare because all easy readjustments within the organic compound can naturally occur during its synthesis. Changes in the orientation of the atoms, however, are still possible.

H.M. Stationery Office has just issued a *Report on Economic Conditions in France in* 1928, by J. R. CAHILL, C.M.G., pp. 344, price 5s. (post free, 5s. 2d.).

It deals exhaustively with State finances, the reconstruction of the devastated areas, general trade and industrial production, transport developments, the country's natural resources and social questions. There are also 16 statistical appendices.

The outstanding feature of British trade with France is that she sends us far more than she takes from us.

This valuable report has been issued from the Department of Overseas Trade and is one of the Department's regular series.

U.S. PUBLICATIONS RECEIVED.

GEOLOGICAL SURVEY.

Studies of Basin-range Structure. By G. K. Gilbert. 60 cents.

Water Supply Paper 590. Part X. The Great Basin. By Nathan C. Grover, A. B. Purton, H. D. McGlashan, F. F. Henshaw, C. G. Paulson, and R. Follansbee. 20 cents.

Water Supply Paper 540. Ground Water in the New Haven Area, Connecticut. By J. S. Brown. 60 cents.

Water Supply Paper 581. North Atlantic Slope Drainages. By N. C. Grover, C. H. Pierce, A. W. Harrington, O. W. Hartwell, and A. H. Horton. 25 cents.

Geology and Lignite Resources of S.W. Dakota. By C. J. Hares. 35 cents.

Geology of the Muddy Mountains, Nevada. By C. R. Longwell. 50 cents.

Bibliography of North American Geology, 1925-26. By J. M. Nickles. 40 cents.

DEPARTMENT OF COMMERCE.

Paint and Varnish Brushes; Surgical Gauze; Folding and Portable Wooden Chairs; Forms; Metal Lath; Steel Barrels and Drums. 5 cents each.

A NEW ELEMENT?

According to *Popular Science* (November, 1928, p. 74) Prof. B. S. Hopkins, of the University of Illinois, has stated that " with calolinium sulphate, science hopes to get to so-called absolute zero, a frigidity of 459 degres below zero."

Forthcoming Events.

ROYAL INSTITUTION.

Tuesday, December 11, at 5.15 p.m.—" Diamonds." By Sir William Bragg, F.R.S.

Thursday, December 13, at 5.15 p.m.—" Human Speech as a Musical Phenomenon." By Sir Richard Paget.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Tuesday, December 11, at 5.30 p.m.—General Meeting, at the House of the Royal Society of Arts, John Street, Adelphi, W.C.2. The following paper will be read: " Madagascar and its Oil Lands." By Arthur Wade, D.Sc., A.R.C.S., F.G.S., M.Inst.M.M., F.Am.G.S., M.Inst.P.T.

INSTITUTE OF METALS.

An election of Members of the Institute of Metals is due to take place on December 19.

Intending applicants for membership should communicate with the Secretary at the Offices of the Institute, 36-38, Victoria Street, Westminster, London, S.W.1.

A BRIEF OUTLINE OF THE HISTORY OF SCIENCE.

By J. G. F. DRUCE.

The recent revival of interest in the history of the Sciences makes the book appeal to the general scientific public. It is also intended for use in Schools, where the History of Science occupies a place in the curriculum.

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PATENTS.

It is desired to secure the full Commercial Development in the United Kingdom of British Patents Nos. 160,148: 166,818 and 225,216, which relate to the Manufacture of Resins, either by way of Sale or the Grant of Licences on reasonable terms. For particulars, apply PHILLIPS'S, 70 Chancery Lane, London, W.C.2.

CHEMICAL SOCIETY'S LIBRARY.

The Library of the Chemical Society will be closed for the Christmas Holidays at 1 p.m. on Saturday, December 22, and will re-open at 10 a.m. on Friday, December 28.

County Borough of Middlesbrough Education Committee.

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W. J. WILLIAMS,
Director of Education.

Education Offices,
Middlesbrough.
3 December, 1928.

MERCHANDISE MARKS ACT, 1926.

An enquiry will be held shortly concerning origin of:—

1. Domestic, fancy and illuminating blown glassware of all descriptions (other than electric lamp bulbs).
2. Pressed glassware of all descriptions.
3. Bottles, jars and other containers of glass.
4. Lampblown ware and scientific glassware of all descriptions, including tubing and rod.
5. Vacuum cleaners.
6. Firearms and parts thereof, except smooth bore tubes.
8. Wideless receiving sets, components and accessories.

The enquiry will be held at the Board of Trade Offices, Great George Street, London, S.W.1. Communications should be addressed to the Secretary, Mr. E. W. Reardon, at that address.

THE ABSOLUTE ZERO OF TEMPERATURE.

By F. H. LORING.

In this Journal during the year 1927 I published a series of papers based upon a "Selective Displacement of 0.0153A in X-Ray Spectral Lines." It was admitted that the experimental basis was poor, but arising therefrom a series of relations were developed. This might be a case where the experimental part can be scrapped and only the correlationships retained.

I note that G. K. Burgess in his paper on the international temperature scale* (see *Chemical News*, 1928, 137, 350 — Book Reviews) uses the value -273.2.

In the *Chemical News*, 1927, 134, 385, I suggest—but with serious doubts—that the above constant can be evaluated out of other constants. To make this study appear more reasonable I may cite *again* that I have been able to arrive at the vacuum velocity of light by the equation : $c = R_\infty / (24 \times 10^{-33} / h) = 29979640853$ cms. per second, when $R_\infty = 109737.\dot{3}\dot{7}$, and $h = 6.55\dot{6} \times 10^{-27}$. Moreover, h can be evaluated from my $\Delta_a = 0.01525165...$, by the equation : $10^{-28} / \Delta_a = h$. Now $10^2 / 24\Delta_a = 273.1944$.

It seems absurd carrying out computatiions so far in the decimal region, that is to say, to so many apparently significant figures. It is only based upon the fact that the values obtained are all so near to the best experimental determinations, that I have jumped to the conclusion that repeating decimals hold good in certain cases above; or, rather, that they are exceedingly close to the true values. This is a dangerous jump; but, so far, it seems near to the mark, for it keeps the values between the extremes. J. R. Cotter (*Phil. Mag.*, 1928, 6, 318) refers to the value obtained by K. Onnes, *viz.* : -273.09°, and that of Henning and Hense, *viz.* : -273.2°. Cotter suggests a modified Kelvin method which would give greater precision than possible by other methods.

As a general rule, when attempts are made to express constants in more significant figures than experiment justifies they turn out to be wrong; so, in my case, I shall not be surprised if this correlationship fails when more exact determinations are made.

I am, of course, also aware of the possibility of a pure chance coincidence, as I see no reason why the absolute zero of temperature should be connected with the constants used. However this may be, arbitrary constants can be introduced into calculations and results obtained that coincide with the best experimental determinations. It may be customary to interpret the constants and thereby give a completely connected scheme of thought, but even in such a case there is danger of error; in fact, it may only become another form of chance coincidence, yet useful results are often obtained. Science is as cautious and sceptical of doubtful relations as ever, but more latitude is allowed, as many facts are being revealed which are beyond our complete understanding.

* *Bureau of Standards Journal of Research*, Oct. 1928, p. 685.

ABSENCE OF EFFECT OF AN ELECTRIC FIELD ON THE MAGNETIC SUSCEPTIBILITIES OF HYDROGEN CHLORIDE AND NITRIC OXIDE.

In the *Physical Review* for November, 1928, L. M. Mott-Smith gives an experimental paper, the title of which is substantially as above. An electric field of about 8,000 volts per cm. was applied to HCl and NO and their magnetic susceptibilities were investigated both parallel and perpendicular to the electric field, with the result that no change in volume magnetic susceptibility in each case was detected. "With the diamagnetic HCl it was supposed that a slight change in the susceptibility might be produced by the electric forces," but no change resulted, and no theory has been attempted by this investigator. "This result can be considered as favouring the new quantum theory, for it seems probable that the old quantum theory would have predicted a change in susceptibility just as was found by L. Pauling (*Phys. Rev.*, 1926, 27, 568) for the dielectric constant in the inverse experiment." A. Huber (*Phys. Zeit.*, 1926, 27, 619) had looked for an electric polarization, but his experiments were negative as applied to NO. The author states that Huber's experiment strengthens the assumption that there is no preference beween left- and right-handed molecules which had been invoked in this connection. See papers by R. de L. Kronig, *Zeit. f. Physik*, 1928, 46, 814; E. Hill and J. H. Van Vleck, *Phys. Rev.*, 1928, 32, 267; also forthcoming papers by Kronig and by Van Vleck. These papers deal with more recent theory which seems to show that a "molecule has on the average no discrimination between left- and right-handed rotations." There are other important references in this paper.

F. H. L.

LOW TEMPERATURE CARBONISATION.

SIGNIFICANT COMMERCIAL DEVELOPMENTS IN FOUR DIFFERENT COUNTRIES.

With regard to low temperature carbonisation and all the recent new Companies in Great Britain it is necessary to emphasise that two of the most essential factors for commercial success in this difficult field, involving the establishment of a vast new industry, are actual large scale experience over a long period, and ample financial resources, obvious of course to anyone experienced in the chemical and allied industries.

A good sign, however, is that important firms in the power world are now taking the matter up, particularly, for example, the International Combustion Engineering Corporation of New York, and their associated Companies, not only in Great Britain—including the Underfeed Stoker Co., Ltd., and Coal Oil Extraction, Ltd., of London—but also other countries, particularly France and Germany, with headquarters in Paris and Berlin respectively.

It is now generally well-known that significant developments are taking place in connection with their "K.S.G." process, including erection of a large-scale plant at the works of the South Metropolitan Gas Company in London, and also at the Mines de Lens in France, for the treatment of small coal, extensions to the original installation at the Karnap Collieries, Essen, represented by the addition of two more retorts, and particularly as regards the plant which will be completed by March next in New Jersey, U.S.A. This will be the largest ever erected in the history of low temperature carbonisation, comprising eight retorts each with a throughput of 80 tons of coal per 24 hours, that is, about 4,000 tons per week.

The many well-known British, American, French, and German engineers associated with the International Combustion Companies have realised for some considerable time past that the next advance in the world of fuel technology is low temperature carbonisation, and it is for this reason that they have concentrated particularly also on the "McEwen-Runge" process for the low temperature carbonisation of pulverised coal, with which large scale commercial experience has already been obtained at the Lakeside Power Station, Milwaukee.

Further, as significant of future developments, International Combustion acquired some time ago the J. T. Lewis Co., the largest firm of tar distillers in the United States, representing, in itself a very extensive organisation, thus ensuring the proper use of the low temperature tar, including use for the manufacture of Bakelite and moulding compounds by interaction with formaldehyde. In general, therefore, after great expenditure, we shall surely have in commercial operation "K.S.G." plants in four of the chief countries of the world, with corresponding developments in the way of utilising the tar, while important progress may be expected in connection with the "McEwen-Runge" process.

THE FERTILISER INDUSTRY IN CANADA.

Canada consumes very small quantities of fertilisers in relation to the great expanse of country devoted to agriculture. A recent survey of the fertiliser trade by the Dominion Bureau of Statistics in co-operation with the Department of Agriculture gave the amount of fertiliser sold for use in Canada in the year ended June 30, 1927, as 169,564 tons, and the area sown to field crops each year as about 56 million acres.

The Bureau has just issued a further Bulletin dealing with the manufacture of fertilisers in Canada during the calendar year 1927, from which it appears that production from plants engaged primarily in the manufacture of complete fertilisers totalled in value last year $1,844,032. In addition, fertiliser materials such as calcium cyanamide, ammonium sulphate, animal tankage, ground bone and fish fertilisers were made in factories classified under other industries; in 1927, the production value of these commodities amounted to $6,278,707.

Only 12 plants in Canada produced complete fertilisers as a major product; 6 were in Ontaria; 2 in Nova Scotia; 2 in British Columbia; and 1 each in Quebec and New Brunswick. Capital employed in these plants amounted to $1,998,811 and the average number of persons employed the year round was 233. Payments in salaries and wages totalled $224,564 and materials used in manufacture cost $1,200,030.

Complete fertiliser was the major product of the industry. In 1927, production amounted to 49,503 tons, worth $1,670,507, of 90 per cent. of the total output of the industry. Superphosphate was actually made in only one plant, although several other manufacturers of complete fertiliser sold quantities of superphosphate after

dilution with a filler to meet the requirements of the trade. One concern was engaged solely in grinding and preparing basic slag. Production of complete fertiliser in other industries amounted to 22,000 tons, worth $876,524, while ammonium sulphate, cyanamide, animal tankage, fish fertiliser and ground bone, used extensively as fertiliser, were also produced by concerns classified to other industries.

Imports of fertilisers and fertiliser materials during the calendar yea r1927 amounted in value to $4,138,053. This total included superphosphate, manufactured fertilisers, sodium nitrate, muriate and sulphate of potash, basic slag, and ammonium sulphate. Exports were valued at $5,379,582 and included cyanamide, ammonium sulphate and manufactured fertilisers.

HONDA'S THEORY OF MAGNETISM.

The above theory was given in full in this Journal (current vol., p. 358). It was based partly on the old quantum theory of definite electron orbits. This quantum theory, as originally developed by Bohr, has been of such great service that it seems best not to discard it entirely in view of the newer theory, but to anticipate readjustments in any successful issues arising from the older theory. As stated before in these columns, the worker of to-day has to regard theories as tools to be used as occasion demands, and some of the older theories are still very useful tools. As Maxwell has wisely written, a theory is a scaffold that enables the workmen to erect structures within it, and a time comes when the outer structure has to be demolished—or something to this effect, as I am writing from memory.

F. H. L.

TENDERS FOR DISINFECTANT FLUID AND SHEEP DIP FOR NEW ZEALAND.

The Officer in Charge of His Majesty's Trade Commissioner's office at Wellington reports that the New Zealand Government Stores Control Board is calling for tenders, to be presented in Wellington by the 1 March, 1929, for the supply of disinfectant fluid and sheep dip.

Firms desirous of offering supplies of British manufacture can obtain further particulars of this call for tenders upon application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference B.X. 4938 should be quoted.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Application for Licences in November, 1928.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 665, of which 580 were from merchants or importers. To these should be added 13 cases outstanding on the 31 October, making a total for the month of 678.

ON THE DRYING PROPERTIES OF THE CELLULOSE ESTER LACQUER.

The drying time of various lacquers and the temperature lowering by drying, were experimented upon by using the mercury thermometer of 1/10°C. graduation, which had a mercury bulb of relatively large and regular form.

The bulb portion of the thermometer is dipped into a lacquer and the lacquer with *its can is make drop naturally, and at the* same time the temperature lowering of the thermometer and the time required for it are recorded. This experiment is carried out in the room of 15.5°-17°C and relative humidity of 55-65 per cent. When the temperature lowering is maximum, the appearance of the fog on the film over the bulb and its following disappearance are recorded. The maximum temperature lowering occurs between 60-160 seconds and the following temperature rise is more slowly.

The forms of the temperature-time curves are different according to the sorts of lacquers. With acetyl cellulose dopes of a high viscosity, which is used generally as aeroplane dopes of good quality, the fog appears gradually during a further drying. Depolimerised acetyl cellulose dopes of a low viscosity shows no fog during this experiment. An acetyl cellulose dope which contains on heavy solvent such as benzyl alcohol shows permanent fog. Nitro cellulose dopes show a similar temperature-time curve as acetyl cellulose dopes and these aeroplane dopes dry to touch up to 1000 seconds later, but modern pyroxylin lacquers show very low temperature lowering, *e.g.*, 2-3°C and do not dry to touch so quickly as dopes and show no fog.

(Japanese Journal of Chemical Industry.)

GENERAL NOTES.

MALAYAN IMPORTS OF CHEMICALS, DRUGS, DYES AND COLOURS.

Imports of chemicals, drugs, dyes and colours into Malaya during the first half of this year amounted to £1,060,142, as compared with £1,240,222 during the corresponding period in 1927.

DOG DISTEMPER.

An important report submitted by the Distemper Research Committee to the *Field* Distemper Council and the Medical Research Council appeared in the Press on the 29 November. It states that the Committee's investigation has reached a point when the knowledge acquired is capable of being usefully applied in practice to rendering dogs resistant to infection by distemper.

The report adds that with the object of providing dog-owners with the means of preventive treatment they have invited a laboratory well equipped for the commercial development of these results to undertake the preparation of the vaccine used with a view to its distribution.

As is only to be expected when a scientific announcement of such importance is made great interest has been aroused amongst owners of dogs, and numerous enquiries made as to where the vaccine can be obtained. It is deemed advisable, therefore, to inform enquirers and others interested that The Wellcome Foundation are actively engaged in undertaking the conversion of the experimental laboratory processes into large-scale production, and in due course hope to be able to issue the vaccine through Messrs. Burroughs Wellcome & Co.

It is announced that Vickers (Aviation) Limited, a company owned entirely by Vickers Limited, engaged in the manufacture of heavier-than-air craft, has acquired all the share capital of the Supermarine Aviation Works Limited. The company is engaged in the manufacture of flying boats and seaplanes, and will be remembered as the constructor of the winning machine in the last Schneider Cup race and of the "Southampton" flying boats now engaged on a world cruise. The Supermarine Aviation Works Limited will continue as a separate company with the same personnel as heretofore.

The Detrick Arch Company announce that they have taken over from the Underfeed Stoker Company Limited all the rights for the design, manufacture and sale of all flat suspended arches and roofs and furnace walls constructed under the patent rights of the M. H. Detrick Company in Great Britain and the British Colonies (excluding Canada).

They have also acquired the rights of design, manufacture and sale of Beco Boiler Baffles for the same countries.

The operations of the Detrick Arch Company will be under the management of Mr. J. K. Mann, formerly with the M. H. Detrick Company of Chicago.

The manufacture of all Detrick patent material is entirely British and sales during the current year have increased 300 per cent.

PYRITES IN COAL.

In the course of an investigation by the Lancashire and Cheshire Coal Research Association into the action of pyrites in relation to the spontaneous combustion of coal, a paper (Safety in Mines Research Board Paper No. 26) was published about a year ago, in which Messrs. H. Macpherson, N. Simpkin, and S. V. Wild gave a general account of the occurrence of pyrites in coal and of the chemical composition of the pyritic material both before and after oxidation.

Another paper, by the same authors, entitled "Pyritic Oxidation, with Special Reference to the Ravine Seam," has just been published (Safety in Mines Research Board Paper No. 47, H.M. Stationery Office, 1s. 6d. net), which gives a comparison of the behaviour on oxidation in the laboratory of the pyrites contained in coal taken from the Ravine Seam, Lancashire, and representing the complete seam from top to bottom, with the behaviour of the corresponding coal *in situ*.

The authors conclude that, while the oxidisable pyrites contained in this coal may assist in a minor degree in the helf-heating of the coal, the most important effect of the pyrites is evidently the disintegration caused in the coal by its oxidation and the greater bulk of the oxidation products.

CANADIAN PROSPERITY.

The Royal Bank of Canada has just published some interesting statistics to shew the great prosperity of most Canadian industries.

An average of the crop estimates of the Dominion Bureau of Statistics indicates that crops of the three prairie provinces will amount to 540 million bushels of wheat, 315 million bushels of oats, 115 million bushels of barley, 15 million bushels of rye, and 4 million bushels of flax. Although August frost damaged the wheat in Saskatchewan and Alberta to a substantial degree, preliminary statistics indicate that wheat will grade much better than in 1927-28 and that protein content will be exceptionally high. The early harvest has permitted rapid movement of the wheat toward the seaboard and some congestion is reported at the terminals. Even though prices should remain somewhat lower than last year, the price factor will be largely offset by the large size and good quality of the crop.

In the first eight months of 1928, the amount of iron and steel produced in Canada exceeded the amount produced during the same months of 1927 by more than 30 per cent.; the newsprint production of 1928 exceeded that of 1927 by 15 per cent.; that of automobiles by 20 per cent.; and that of flour by 16 per cent. In the tables given are shown the index of electrical energy production. The amount of energy generated in Canada for Canadian use in 1928 exceeded the amount generated in these same months of 1927 by 19 per cent. Canadian manufacturing activity has been at a much higher level in 1928 than during 1927, and 1927 was a year of record breaking activity.

ARTIFICIAL SILK TO BE CHEAPER.

A remarkable discovery in the manufacture of artificial silk by which, on the authority of many experts in this country, the cost of production will shortly be very much reduced while virtually eliminating the present heavy percentage of inferior thread, was made known recently by one of the leading firms engaged in the industry.

This development takes the form of new processes which, as proved by strict tests in England and on the Continent, increase the production of first quality silk from usually below fifty per cent., under the methods now employed, to a minimum of ninety per cent. It does away almost entirely with the handling, which at present is responsible for such damage to thread in the course of manufacture, that practically half the finished product has to be sold as lower grade material.

Altered Standard of Value.

It follows that the silk of first quality, now below half the output of the factories, must be sold at a relatively higher price to make up for the lower prices obtainable for deteriorated thread, which costs just as much to manufacture. By reducing the waste on the lower grades to the narrow margin of ten per cent., or less, and making, at the same time, immense savings of cost in the entire process, the standard price of the finest fabric will, it is anticipated, become substantially lower.

New British Industry.

It is gratifying to learn that though the organisation responsible for the practical development of this discovery now produces only on the Continent, the manufacture of artificial silk under the new processes will begin in works occupying a 43-acre site acquired for the purpose by the International Silk Company Limited, at Littleborough, near Rochdale.

OPTICAL EXPERIMENTS WITH ELECTRONS, WITH PARTICULAR REFERENCE TO GAS SURFACES.

Chemists cannot afford to ignore the advances being made in physics, as industrial chemistry is constantly drawing from the reservoir of pure science, which contains a host of physical facts and some powerful tools of theory.

L. H. Germer continues his description of electron waves in an experimental survey of his work, in connection with C. J. Davisson, in the October issue of the *Journal of Chemical Education*. See also Davisson and Germer, Reflection and Refraction of Electrons by a Crystal of Nickel, *Proc. Nat. Acad. of Sci.*, 1928, 14, 619, August.

The first part of Germer's paper was touched upon in this Journal of Nov. 2, 1928, p. 274, by myself. The part here briefly sketched relates more particularly to the refraction of electron waves, and some important features are brought to light. I will confine this sketch to some of these features. Germer says: "Electron waves differ from X-radiation of the same wavelength in certain important respects: they are scattered much more effectively by the atoms of the crystal and they are extinguished in penetrating into the crystal at a much more rapid rate. Thus the diffraction of electron waves occurs entirely in the few top layers of atoms at the very surface of a diffracting crystal. We believe that this circumstance will prove to be of considerable importance—as it suggests that in electron diffraction we have a new means of exploring the region at and near the surface of the crystal, a region which is inaccessible to X-ray investigation. This new

tool, which might well be called 'electron diffraction analysis,' may be expected to yield results concerning surfaces quite similar to the results which X-ray diffraction analysis yields concerning volumes. A considerable amount of information regarding the surface of our nickel crystal has been literally forced upon us, and there seems reason for believing that we have now at hand a tool of really tremendous power for studying the micro-structure of surfaces."

Gas condensation on the crystal surface was made evident by the behaviour of the electrons, as from the diffraction patterns obtained it was possible to determine the amount of gas so adsorbed, and cleanliness to the elimination of the last layer of gas was detectible. Electron bombardment was used to heat the crystal and remove the gas.

"At an early stage of this gas deposition an entirely new class of diffraction beams makes its appearance. These new beams increase gradually in intensity, reach a maximum and then decrease, finally disappearing at about the same time as the disappearance of the 'grazing beams.' These new beams are plane grating beams arising from the very first layer of gas atoms on the crystal surface. One family of these beams appeared in each of the three principal azimuths of the crystal. . . ."

"By means of this diffraction analysis we have thus deduced the fact that the first gas atoms settle upon the clean surface of our nickel crystal in vacuum, and arrange themselves in a structure similar to the structure of the top layer of nickel atoms, but having a scale factor twice that of the nickel atoms." In the figure an orderly arrangement is shown. Heating appears to destroy the regular arrangement of the atoms. Germer says : "Apparently we can have the gas on the surface as a two-dimensional liquid instead of a two-dimentional crystalline solid. The melting point of this two-dimensional gas crystal is found in this manner to be in the neighbourhood of 150° C."

The original should be studied, but it is quite clear, as Germer says, that the information possible to obtain by this method is of great scientific importance, for here is a method of probing the action of the catalyst, so that one may know in detail what happens when nitrogen and hydrogen are brought together in contact with certain oxides which act as catalysts.

F. H. L.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, December 6.

The following papers were read :—

The Inheritance of Sinistrality in Limnæa peregra. By A. E. Boycott, F.R.S., C. Diver, S. Hardy, and F. M. Turner.

1. *L. peregra* is normally dextral; a sinistral variety, in which the spiral twist of body and shell is completely reversed, is very rare.

2. Sinistrality behaves as a mendelian recessive, but the appearance of any change of twist imposed by crossing is delayed one generation. Thus a sinistral fertilised by a dextral produces (F1) sinistral young, which (F2) produce dextral broods : these produce (F3) dextral and sinistral broods in proportion 3 to 1. Similarly, dextral fertilised by sinistral produces dextrals in F1 and F2, and a 3 to 1 mixture of dextral and sinistral broods in F3.

3. Albinism in this snail is a also a simple mendelian recessive and inherited directly : albino fertilised by pigmented produces pigmented young in F1, and F2 consists of broods each containing pigmenteds and albinos in proportion 3 to 1.

4. It is suggested that the delay in inheritance of sinistrality is due to the twist of animal and shell being determined at the second—possibly at the first—division of the egg, which takes place soon after entrance of the spermatozoon. Pigmentation and shell-shape not being fixed till later the spermatozoon has more time to bring its influence to bear.

5. This simple scheme of interitance is interfered with by a tendency for sinistrals to become dextrals (phenotypic or genotypic).

A System of "Fine" Vessels Associated with the Lymphatics in the Cod (Gadus morrhua). By R. H. Burne, F.R.S.

In 1926 a description was published of a system of "fine" vessels (with the structure of small arteries) associated with the superficial lymphatics of the head and fore-part of the body of *Lophius*. In the present paper a similar system is described in the Cod and *Pagrus*, and reference is made to parts of the system described by authors in the tail of Teleosteans. In the Cod these vessels follow the chief arteries (except those to viscera) and extend along aorta to tail. They have minute connections with efferent branchial vessels; connections are

also recorded (in other species) with arteries in tail region. Peripherally, the vessels break up in skin and mucous membrane of the mouth and pharynx, there communicating with capillary plexus of lymphatics.

The facts indicate the vessels as morphologically part of arterial system. It is suggested that the lymphatics evolved by modification of part of blood vascular system, which comprised at outset of specialisation both arteries and veins. By progressive modification the venous component became transformed into definitive lymphatics, whereas the arterial component vanished. In Teleosts the arterial component persists as the "fine" vessels.

Such interpretation would seem to be in accord with Cole's description of red lymphatics in *Myxine* with arterial tributaries; it also offers explanation of the two-fold lypmh circulation in young Teleosts (Jourdain and Mayer) and of presence of blood in lymphatics of Teleosts and lower Fishes.

Papers read in title only:—

The Diffusion of Oxygen and Lactic Acid through Tissues. By A. V. Hill, F.R.S.

The diffusion of dissolved substances through tissues is considered for certain cases which are mathematically soluble. Such are: a plane sheet; a semi-infinite solid; a cylinder.

Part I deals with "steady state," in which oxygen is being used (or lactic acid produced) at same time as it diffuses. Part II treats of kinetics of diffusion of a single dissolved substance, and of such problems as time taken for saturation of tissue with oxygen. Part III deals with kinetics of the diffusion of two reacting substances, particularly with oxygen into tissue in which recovery is necessary at every point before the oxygen can advance. Part IV attempts to deal with the complex problem of diffusion of carbon dioxide (existing as dissolved gas and as bicarbonate ions): existing experimental data are however inadequate.

In addition to mathematical equations, numerical examples are given, dealing with matters of importance particularly in muscle and nerve physiology.

Cytochrome and Respiratory Enzymes. By D. Keilin, F.R.S.

Cells of aerobic organisms contain four hæmatin compounds: an unbound hæmatin and the three hæmatins (a', b' and c') of cytochrome. The components a' and c' of cytochrome are not autoxidisable, while b' of cytochrome and the protohæmatin are autoxidisable, the latter combining also with CO. The four hæmatin compounds are responsible for the thermostable peroxidase reaction of the cells. In addition to these hæmatin compounds, cells contain also a thermolabile indophenol oxidase, catalysing the oxidations of various artificial chromogens.

All factors such as KCN, H_2S, CO, and warming above 70°C., which inhibit or suppress activity of indophenol oxidase, affect in same way the oxygen uptake of the cell, which shows that this oxidase takes an important part in cellular respiration. Cytochrome (especially a' and c') is oxidised by indophenol oxidase and is reduced by dedydrases. Cytochrome acts therefore as a carrier between two activating mechanisms of cells: dehydrases and oxidases. Autoxidisable component b' of cytochrome and free protohæmatin can act as carriers between the dehydrase system and molecular oxygen, and also as direct catalysts promoting oxidation of substances not activated by specific dehydrases.

The Ultra-Violet Absorption Spectra of Certain Aromatic Amino-Acids and of the Serum Proteins. By F. C. Smith. Communicated by C. Lovatt Evans, F.R.S.

Amino-Acids. — Ultra-violet absorption spectra of tyrosine, tryptophane, and phenyl-alanine have been measured. In tyrosine, two new bands have been found, at wave-lengths A 2240 and 1940. The complex spectrum found by Ward in phenyl-alanine is not supported by the present findings.

Serum Proteins.—Samples of exceptional purity were employed. The following experiments were conducted, to obviate any source of error:—(1) It was shown that the protein solution did not cause scattering, but true absorption occurred. (2) Samples were ultra-filtered, to exclude possible presence of diffusible substances. (3) It was shown that, though proteins are precipitated by ultra-violet radiation, the exposure necessary for photography causes no measurable change in spectrum.

THE CHEMICAL SOCIETY.

Papers read on Thursday, December 6:—

The Mechanism of Corrosion. By U. R. Evans.

The corrosion of zinc, aluminum, iron, steel, and copper in salt solutions commences at a limited number of "weak points" in the invisible oxide film; in the case of zinc, iron, and steel it spreads out

rapidly until most of the immersed surface is affected. The weak points are mainly situated along the bottom or cut edges of specimens, but are sometimes found at surface defects in the centre, or in special circumstances at the water line. Four types of final corrosion products are obtained according to the manner in which anodic and cathodic products come together.

Quantitative experiments show that, under conditions of differential aeration, electrolytic iron is attacked nearly as fast as steel, whilst potassium sulphate and potassium chloride cause similar rates of total corrosion, notwithstanding that the shapes of the corroded areas are quite different; magnesium sulphate causes slower attack. Zinc is attacked more quickly than iron, and aluminium much more slowly. Oxygen produces quicker attack than air, but it is restricted to a smaller area; doubling the breadth of half-immersed specimens nearly doubles the corrosion, but increase of the length of th specimens has much less effect on the rate of attack. An interpretation of these results is given.

The Properties of Conjugated Compounds. Part IV. The Dibromination Products of Cyclic Butadienes. By E. H. FARMER AND W. D. SCOTT.

The dibromination of $\Delta^{1:3}$-*cyclo*hexadiene and *cyclo*pentadiene has been studied with the object of correlating (if possible) the ease of isomerisation of the 1 : 2-dibromides with the assemblage and relative proportions of the bromides in the bromination mixture.

Hitherto, only 1 : 4-dibromides of the two hydrocarbons bave been described. 1 : 2-Forms are, however, obtainable and in the instance of *cyclo*hexadiene appear to be the sole primary products. Again, in these additions, a specific solvent influence is apparent; also the alternative incidence of *cis*- and *trans*-1 : 4-forms is affected by dilution. Although precise comparative measurements of the velocity of 1 : 2- ⟵ 1 : 4-change in these and previously studied examples have not yet been possible, the observations made do not accord well with the view that the orientation of the products in the bromination mixture is controlled by a purely ionic mechanism.

The Stereoisomerism of Disulphoxides and Related Substances. Part IV. Di- and Tri-Sulphoxides of Trimethylenetrisulphide. By E. V. BELL AND G. M. BENNETT.

The oxidation of trimethylenetrisulphide by hydrogen peroxide under carefully controlled conditions converts it successively into a *monosulphoxide*, two isomeric *disulphoxides* (α-dioxide, dimorphous; β-dioxide 8 times as soluble in water as its isomeride) and two isomeric *trisulphoxides* (β-trioxide 11 times as soluble in water as the α-trioxide).

The existence of two disulphoxides and two trisulphoxides of trimethylenetrisulphide was to be expected according to stereochemical theory; moreover, the genetic relationship between the substances now described leads to an absolute determination of their configurations.

The Structure of Organic Molecular Compounds. By G. M. BENNETT AND G. H. WILLIS.

The theory of the union of organic molecules by means of the residual valency of a whole molecule or group ("Restfeldtheorie") is exmined and rejected in favour of the hypothesis that union occurs by definite, localised bonds. The following classes of complexes are discussed : those of (poly)nitro-compounds with bases or aromatic hydrocarbons; of benzoquinone with amines; of halogen compounds such as chloroform or iodoform with ether or bases; and the complexes responsible for the halochromism of quinones, ketones and bases. Formulæ are developed for such additive compounds.

A number of new molecular compounds of several types are described. Observations of the volatility and solubility relations of the isomeric nitrobenzyl-dialkylamines (*o*-*m*-, and *p*-$C_6H_4(NO_2).CH_2.NR_2$) afford evidence in support of the formula proposed for the complexes of nitro-compounds with bases.

Hexa-aminobenzene. By B. FLÜRSCHEIM AND E. L. HOLMES.

Attempts to prepare hexa-aminobenzene had hitherto failed, but its preparation has now been accomplished by the reduction of 2 : 4 : 6-trinitro - 1 : 3 : 5 - triaminobenzene with phenylhydrazine. Hexa-aminobenzene is a crystalline compound, m.p. 247-248° (decomp.) in hydrogen, somewhat higher in air. It is soluble in water, but insoluble in nearly all organic solvents. It forms a tetrahydrochloride (no m.p.), a tripicrate, and a hexa-acetyl derivative (no m.p.). It is coloured brown by air, but less rapidly than the tetra-aminobenzenes or than penta-amino-benzene (now also obtained in the

free state by means of phenylhydrazine, and decomposing in air at about 200°).

The relative stability of hexa-aminobenzene is explained by increased neutralisation of residual affinity (between adjacent nitrogen atom as well as though the ring), due to symmetrical affinity distribution.

Reduction by phenylhydrazine has been extended to other poly-nitro-derivatives.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held in the Chemical Society's Rooms, Burlington House, on Wednesday, December 5, the President, Mr. Edward Hinks, being in the chair.

Certificates were read for the first time in favour of William Bennett Adam, M.A., A.I.C., Alfred Louis Bacharach, B.A., F.I.C., Andrew Dargie, B.Sc., A.I.C., Wadie J. Itayim.

Certificates were read for the second time in favour of Edwin Herbert Bunce, A.I.C., Frederick O'Brien ,M.Sc., F.I.C., William Macro Seaber, B.Sc., F.I.C., John Graham Sherratt, B.Sc., F.I.C.

The following were elected members of the Society :— Charles Wesley Bayley, Harry Brindle, B.Sc., A.I.C.. William George Burgess, George Leonard Clothier, Hector Ingram Downes, M.Sc., A.I.C., Alec Walter Greenhill, M.Sc., A.R.S.Sc., A.I.C., Donald R. Hayward, B.Sc., B. L. Khuller, M.Sc., A.I.C. James Donald Kidd, B.A., M.Sc., A.I.C., Herbert Drake Law, D.Sc., F.I.C., Sidney John Saint, B.Sc., A.I.C.

The following papers were read and discussed :—

The Occurrence and Determination of Boron Compounds in Vegetable Products. By A. Scott Dodd, B.Sc., F.I.C.

Boron compounds were found in a large number of dried fruits and determined by a modification of Thomson's method, the results being confirmed colorimetrically. The amount of boron compounds (expressed as boric acid) found in dried raisins and currants ranged from 110 to 260 parts per million, and in miscellaneous dried fruits from 40 parts per million in prunes to 300 parts per million in apricots and peaches. In fresh fruits the quantities varied from 31 to 62 parts per million, coresponding to 280 to 550 parts per million on the dry substance.

Chemical Tests for Drunkenness : The Determination of Small Quantities of Alcohol in Urine. By John Evans, F.I.C., and A. O. Jones, M.A., F.I.C.

The method consists essentially in evaporating the urine in a current of air, and conducting the mixture of air and alcohol vapour into a strongly acid solution of potassium dichromate. The alcohol is oxidised to acetic acid, and the unreduced dichromate is determined by adding potassion iodide and titrating the liberated iodine with standard thiosulphate solution. An ingenious apparatus designed for the purpose by Dr. H. W. Southgate was described.

An outline was given of the experimental results obtained by Dr. Southgate, upon which the physiological interpretation of the amouut of alcohol found in urine is based, together with an account of determinations made by the authors upon samples of urine from subjects who had consumed known amounts of alcoholic drinks. The medico-legal application of the method was discussed.

The Analysis of Mixtures Containing Acetone, Ethyl Alcohol and Iso-propyl Alcohol. By C. A. Adams, B.Sc., F.I.C., and J. R. Nicholls, B.Sc., F.I.C.

Tables have been made of the specific gravities and refractometer readings of aqueous mixtures of acetone and the lower alcohols, and these tables can be used for calculating the proportion of three of these ingredients, provided that one of the three can be determined by an independent method. A colorimetric method of detecting and determining acetone has been based on the formation of indigo when sodium hydroxide is added to a mixture of *o-nitro*-benzaldehyde and acetone, and this method can also be used for isopropyl alcohol after oxidation to acetone, whilst ethyl alcohol in the mixture may be determined by oxidation to acetic acid, which is then distilled and titrated.

The Specific Gravities and Immersion Refractometer Readings of Dilute Mixtures of Acetone and Water. By J. R. Nicholls, B.Sc., F.I.C.

Pure acetone was prepared from the commercial product by oxidising impurities, distilling, drying the distillate and refractionating it by distillation until constant in weight. It was also prepared in a similar way from the sodium iodide compound. Mixtures containing up to 10 per cent. of these pure acetones with water were made and their specific gravities and refractometer readings determined.

The Wijs Iodine Method as the Standard for Iodine Absorption. By J. J. Wijs.

The author's method, which was adopted

as the standard for iodine absorption of oils and fats at the International Congress of Pure and Applied Chemistry, has been adversely criticised on the grounds that substitution as well as addition occurs, and that theoretical values are not obtained with certain fatty acids. The author shows that the first criticism is based on erroneous data, and that the second was due to the Wijs reagent used having been prepared by an incorrect formula.

ROYAL INSTITUTION.

A general meeting of the Royal Institution was held on Monday, December 3, Sir Arthur Keith, Treasurer and Vice- President in the chair. Miss Edith Aird, Sir John Aspinall, Sir John Beale, Mr. R. T. Beatty, Miss K. Hartree, Viscount Hambleden, Mr. E. Hatchek, Mr. B. Hennell, Mr. C. W. G. Hindley, Mr. J. S. Oliver, Mr. R. Pigott, Miss L. Power, Mrs. E. A. Ronald and Mr. C. Swithinbank were elected Members.

THE GEOLOGICAL SOCIETY.

November 7, Prof. J. W. Gregory, LL.D., D.Sc., F.R.S., President, in the chair.

Alfred Boyes, Assoc.Inst.M.M., c/o Trepca Mines, Ltd., Kos, Mitrovica (Yugoslavia); Edward Patrick Corbett-Sullivan, Mining Engineer, 30, Bury Street, W.1.; Edward Ashton Craven, B.A., 28, Methuen Park, Muswell Hill, N.10; George Dickinson, B.Sc., c/o Sarawak Oilfields Ltd., Miri, via Singapore; Bankim Bihari Gupta, Calcutta (India); Robert Alexander Keble, Fair View, 63, Dixon Street, Malvern, Victoria (Australia); Lakshmeswar Rama Rao, M.A., Chamarajapet, Bangalore City (India); Cecil Thomas Madigan, M.A., B.Sc., Blackwood (South Australia); Frederick Pill, 31, Slade Road, St. Austell (Cornwall); Maneck B. Pithawalla, B.A., B.Sc., 3c, Garden Road, Karachi (India); Charles Maurice Tattam, Ph.D., B.Sc., c/o the Royal School of Mines, London, S.W.7; Edmond Martin Venables, 3, Marine Parade, Bognor (Sussex); John Weir, M.A., Ph.D., 192, Hyndland Road, Glasgow, W.2.; Oliver Augustus Leslie Whitelaw, M.Inst.M.M., Sekondi (Gold Coast); and Yvor Patten Wilson, A.R.S.M., Talbot Lodge, Clarence Road, St. Albans (Hertfordshire); were proposed as Fellows of the Society.

Dr. L. F. Spath then proceeded to give an account of the recent landslide at "Windy Corner," above Rocken End, in the Isle of Wight, and referred to some alarming reports that had appeared. He showed a series of lantern-slides, which, as he suggested, told their own story.

The structure of the Undercliff was simple; it was not unimportant to remember that there was a slight seaward dip, and that porous rocks rested on impervious clays. Landslips were thus bound to recur at more or less frequent intervals. The resisting and curiously weathered chert-beds that form so conspicuous a feature near the top of the cliff, occasionally overhang, but, in spite of being extensively fissured, they do not break away so readily as might be imagined. In July, however, there was a considerable fall; and some views taken while this fall was actually in progress were most impressive. After this fall the debris of Chalk, Chloritic Marl, and "Upper Greensaud" were banked up against the cliff, reaching almost to the top and covering the road below.

After two months the unstable foundation on which this enormous weight had fallen (that is, remains of previous falls and landslips)gave way. On September 21 there was a vast subsidence of the pile of rocks at the top, and a slipping of the whole Undercliff in front of it out to sea. The slide was doubtless helped by the lubricating action of the water thrown out at the junction of the porous rocks above and the Gault clay below. Moreover, the Gault not only formed the foundation (resting on a more solid base of the Sandrock Series), but was present in various isolated masses brought down in former landslips, and all this confused mass was constantly being eroded at the seaward end. The upper portion of the sunken mass with its chasms, leaving a fine, slickensided, cliff-section down almost to the base of the Gault (250 to 300 feet from the top), was particularly impressive. Lower down, there were seen remains of the ashphalt surface of the destroyed Undercliff road (about 900 feet altogether), pushed down by the rock avalanche, a pond in course of formation, and the heavily fissured ground below as far as Rocken End. This quaking ground of confused material, being forced forward, even pushed up the floor of the sea, and formed a ridge, a little way out, which, however, was rapidly worn away again.

The whole mass was still moving, and small fresh falls occurred during the speaker's visit a few days after the slide; but he appealed to the Fellows to look for ammonites in the Passage-Beds between the Gault and the "Upper Greensand" as soon as the cliff-section was appproachable, perhaps in the spring.

The follolwing communication was read :

The Sequence of Non-Marine Lamellibranchs in the Coal Measures of Nottinghamshire and Derbyshire. By SYDNEY GEORGE CLIFT, B.Sc., F.G.S. AND ARTHUR ELIJAH TRUEMAN, D.Sc., F.G.S.

Mineral secimens from Switzerland, collected by F. N. Ashcroft, M.A., F.G.S., were exhibited by him.

Specimens of Non-Marine Lamellibranchs from the Coal Measures of Nottinghamshire and Derbyshire were exhibited by S. G. Clift, B.Sc., F.G.S., in illustration of his and Dr. Trueman's paper.

At the next Meeting, on November 21, the following communications were read :—

The Geology of the Country Around Kenilworth (Warwickshire). By F. G. SHOTTON, B.A., F.G.S.

The Carboniferous Section at Cattybrook, near Bristol. By STANLEY SMITH, M.A., D.Sc., F.G.S., AND PROF. S. H. REYNOLDS, M.A., Sc.D., F.G.S.

At the Meeting on December 5, 1928, a lecture was delivered by John Walton, M.A., F.G.S., on " Recent Improvements in the Technique of Examining Fossils, and their bearing on the Nature of Fossilation." The following communication was also read :—

The Erattic Rocks and the Age of the Southern Limit of Glaciation in the Oxford District. By K. S. SANDFORD, M.A., Ph.D., F.G.S.

The Council of the Geological Society of London announces the receipt of a generous gift of $10,000 Dominion of Canada 4½ per cent. Bonds from Mr. J. B. Tyrrell, M.A., B.Sc., F.G.S., the well-known Canadian Mining Geologist, for the foundation of a Fund, to be known as the J. B. Tyrrell Fund, the interest of which is to be devoted to the furtherance of the knowledge of the Geology of the Dominion of Canada among the geologists of Great Britain and Ireland.

The first award from this fund will be made in February, 1929, and applications are now invited from British and Irish geologists who desire to visit the Dominion of Canada for the purpose of study or research, and who require assistance in the payment of the necessary travelling and living expenses. The amount of the fund available for this award is £100. Details of the conditions governing the disbursment of this fund, and of the form of application required can be obtained from the Secretaries, The Geological Society of London, Burlington House, Piccadilly, London, W.1.

THE INSTITUTE OF METALS.

GENERAL MEETINGS OF THE INSTITUTE, 1929.

March 13. Twenty-first Annual General Meeting, 10 a.m., in the Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1.

Annual Dinner and Dance, 6.45 p.m., at the Trocadero Restaurant.

March 14.—Annual General Meeting, continued, 10 a.m., in the Hall of the Institution of Mechanical Engineers.

Conversazione and Exhibition, Science Museum, S.W.7., at 8 p.m.

May 7.—Anuual May Lecture, by Sir Oliver Lodge, F.R.S.

September.—Annual Autumu Meeting, Düsseldorf, Germany..

" COMING-OF-AGE " OF THE INSTITUTE.

The Council of the Institute of Metals has found it necessary to alter the date of the 21st Annual General Meeting and " Coming-of-Age " Celebrations of the Institute, from that originally announced (March 6 and 7) to March 13 and 14 next.

In addition to a dinner and dance at the Trocadero on March 13, an interesting function is being arranged for the second day of the Meeting. This is a conversazione and exhibition to be held in the Science Museum, South Kensington, on March 14. Objects of special interest in relation to the work of the Institute wil be displayed; offers of such objects are invited and should be made to the Secretary, Mr. G. Shaw Scott, M.Sc., 36-38, Victoria Street, Westminster, London, S.W.1.

The Annual May Lecture of the Institute is to be given on May 7, by Sir Oliver Lodge, F.R.S.

The Annual Antumn Meeting will be held in Düsseldorf next September. Offers of papers for that meeting are invited by the Council which, it is understood, will particularly welcome papers dealing with matters of practical interest. It is proposed also to hold at Düsseldorf a General Discussion on Laboratory Methods of Metallurgical Research, in which speakers from many countries are expected to participate.

Applications for membership are now being submittted so freely, it is stated, that it is expected that the Institute's membership total will reach the 2,000 mark before December 31 next.

THE PHOTOMICROGRAPHIC SOCIETY.

At the meeting on December 6, Mr. E. H. Elles, F.R.M.S., read a paper on " Resolution in Photomicrography," in which he

criticised some of the assumptions and reasoning which have been expressed on the subject.

The current issue of the *Journal* contains several articles of note : "The Photography of Living Mosses," by W. H. L. Baddeley; "Photomicrography in Veterinary Practice," by A. J. Becket; "Stereoscopic Photomicrography," by E. Curzner, F.R.M.S.; and "The Investigation of Failures in Steel Material," by Capt. J. W. Bampfylde, A.R.S.M., F.R.P.S.

The contributions are illustrated with photographs or photomicrographs, and those for Capt. Bampfylde's article being of special scientific interest.

GLASGOW ROYAL TECHNICAL COLLEGE.

The 1928 annual report of this college contains a retrospect of past work as well as that of the curernt year.

From the days when Thomas Graham opened in "the Andersonian" (the predecessor of the presentbuilding), the first British laboratory for public instruction in Chemistry, practical instruction in the laboratory has formed an ever-increasing part of the College curriculum. In planning this new building the Governors determined that laboratories should be provided which would give ample scope for that close personal contact between teacher and student essential to true education. The extensive scale of the chemical laboratories was specially criticised. It is sufficient to state that development has necessitated the provision of five additional laboratories in this section alone, and most of the space required has only heen obtained by placing the contents of the museums in the corridors. The workships made available by the transference of the craft classes to the Glasgow Education Authority have been converted into nine additional laboratories to meet the needs of Engineering and Mining.

It was fortunate for the College that, having for forty years offered instruction in a number of crafts, the Governors made large provision for this work in the new building. The responsibility for it has since been placed by Parliament upon the Education Authorities, and the transfer of the craft classes to the Glasgow Authority made possible an expansion of the essential work of the College beyond the expectation of even the far-seeing Governors then in office.

But great as the changes are which have been made in the building and equipment, they are only the outward and visible sign of the greater change which has taken place in internal organisation. From being a collection of units, each doing its work without much reference to its neighbours housed in other parts of the City, it became one whole as homogeneous in structure as the building it occupied, each Department working in conjunction with its fellows, each bearing its own burden, but each giving help to its partners, and all united in the determination that the College should be thoroughly qualified to fulfil its missions—firstly, the training of its students in the field of Applied Science; secondly, the service, through investigation and research, of the great industries with which it is associated.

Freedom to plan its own course under new conditions was the priceless gift bestowed upon the College twenty-five years ago by the Scottish Education Department after that Departmen had taken over from the Departmen of Science and Art the duty of supervising the expenditure of the grants from the State which form a large proportion of the College income. Since the transfer the Scottish Department has never ceased to show a paternal interest in the welfare of the College, and has taken care that it should not be shackled with the limiting and irritating regulations of earlier years. Having laid down certain general conditions under which the State aid it administered would be continued, the Department left the Governors free to use their resources as they thought fit in guiding the destinies of the College. his confidence the Governors have striven to justify.

The results of the team-work which thus became possible are most obvious to those who have been its subjects, hut a wider recognition of the success it has achieved is indicated by the affiliation o fthe College to the University of Glasgow under an Ordinance confirmed by the Privv Council, by its inclusion as a University College in the list of University Institutions receiving financial aid direct from the Treasury, and by the authority of His Majesty King George V to assume its present title of "The Royal Technical College."

It is impossible by means of figures to give a measure of the progress here indicated, but the standard of instruetion has greatly advanced. The qualification on entrance required from students proceeding to a degree is the same as that required by all the Scottish Universities. Students of seventeen years of age and over who have no had the benefit of a complete Secondard

School course leading to the Leaving Certificate may enter upon a diploma course if they give evidence of ability to profit by classes on a University standard. The imposition of these preliminary requirements has rendered possible a general raising of the standard of the whole of the day classes involved, and yet the number of class enrolments has doubled.

In the evening classes the change has been even greater. In addition to the craft classes already referred to, large elementary classes have been handed over to the County Education Authorities under a scheme of affiliation in charge of a Joint-Committee. The Authorities are entirely responsible under this scheme for the earlier years of the courses arranged for evening students before they pass on to the College itself. The College is therefore enabled to concentrate upon more advanced work, and to offer facilities to its evening students comparable to those provided for day students proceeding to graduation, while there are still more advanced courses in special fields. Notwithstanding these wholesale transfers, the number of evening students remains at about the maximum which the College building can effectively accommodate.

Accompanying this general rise of standard there has been a large extension of the sphere of work undertaken by the College. The most prominent additions are a Professorship and Department of Civil Engineering, a Chair of Mining, separate Chairs of Organic and Inorganic Chemistry, a Chair of Bacteriology, Associate Professorships in Natural Philosophy and Mechanical Engineering, and Lectureships in Economic Geology, Physical Chemistry, Building, and Engineering Production. The former Weaving College of Glasgow has been merged in the College, and now forms the Department of Textile Manufacture. Complete Schools of Navigation, Pharmacy, and Bakery have been established, which are now among the largest of their kind. The Glasgow School of Architecture, maintained jointly by the College and the Glasgow School of Art, is one of the few fully "recognised" Schools associated with the Royal Institute of British Architects. In this period of twenty-five years the number of members of the staff giving their whole time to the College ras risen from 29 to 93.

Probably the most significant feature in the evolution of the College was the establishment of the New Development Fund, initiated by the former Chairman of the Governors, Sir George Beilby, LL.D., D.Sc., F.R.S. The main object of this fund is the support of research, and in the laboratories of all the chief Departments research is being steadily pursued. The four annual numbers of the "Research Journal," published by the College, contain about sixty original papers in Natural Philosophy, Chemistry, Metallurgy, Engineering, and Bacteriology. The reception given to these issues has been very gratifying, but a yet more satisfactory indication that the College is fulfilling its mission in the furtherance of the applications of Science to industry is the large and increasing number of requests received from local firms for assistance in dealing with problems arising from the use of new alloys and materials in engineering and other industries.

Notwithstanding the unfortunate condition of the Engineering, Shipbuilding, Mining and Metallurgical industries with which the College is closely linked, there has been no diminution in the number of students. The total number in attendance during the past session, 4,619, was exactly the same as in Session 1926-27, but the day students, 931, were three fewer, and the evening students, 3,328, were three more than in that Session.

NOTICES OF BOOKS.

Soluble Silicates in Industry. By JAMES G. VAIR. Pp. 443. New York: Chemical Catalog Co. 1928. Price $9.50.

The discovery of a soluble silicate is given by Pliny, who relates that some sailors used lumps of soda to support their cooking vessels over the fire on a sandy beach. Soda and sand fused to form a soluble glass. "Basil Valentine" and Glauber, in the Middle Ages, mention similar products, but the beginning of its industrial use was due to John Nepomuk of Fuchs, in 1825, who used solnble potassium silicate for coating special glasses and as a cement or glue. It was known as water glass, a term now used of sodium silicate. Fuchs also suggested the applications of soluble silicates in fireproof paints, for artificial stones and for laundry work.

The industrial preparation of thes substances has developed especially in America where the Philadelphia Quartz Co. began making them in 1864 and to-day half a million tons are produced annually in America alone, Great Britain probably coming next with less than a sixth of that production.

In the present volume, the author describes the preparation, nature and constitution of silicate solutions and gels, their reactions and (often unusual), properties,

their commercial forms and their wide and various uses. Much time and patience has evidently been devoted to the accumulation and arrangement of the mass of information which is presented in a manner which stamps the volume as an authoritative treatise on the subject. It is an " American Chemical Society Monograph," published by the Chemical Catalog Co.

Annual Survey of American Chemistry. Vol. III. Edited by CLARENCE J. WEST. Pp. 395. New York : Chemical Catalog Co. 1928. Price $3.

This survey of American research work for the period July ,1927—July, 1928, follows the style of the British Annual Reports, bnt unlike them it is purely " national," being confined to American chemical researches. The survey is issued under the auspices of the Division of Chemistry of the U.S. National Research Council, and has been compiled with the aid of over 50 eminent specialists and technologists.

Whilst many of the chapters and essays reach a high level and are comprehensive compilations with extensive references there seems no definite plan of arrangement and the treatment seems, in places, unequal. Nevertheless, as reviews of America's annual contributions to the advancement of pure and applied chemistry the Annual Surveys are invaluable.

PUBLICATIONS RECEIVED.

U.S. Bureau of Standards. (Simplified Practice Recommendations). — Adhesive Plaster, Structural Slate, 10 cents each.

International Yearbook of Agricultural Statistics, 1927-28.

The International Institute of Agriculture at Rome has recently published its *International Yearbook of Agricultural Statistics* 1927-28. This Statistical Yearbook has from the first been a special feature among the publications of the Institute, the first volume being issued in 1910 and others following in regular succession despite the special difficulties of the war period. The present Yearbook is actually the seventeenth of the series and as usual it contains a mass of agricultural data and material such as by the nature of the case are not to be found in any other publication of similar character.

An idea of its comprehensive nature may be gained by a glance at the subjects of the nine chapters into which this stout volume of nearly 600 pages is divided.

These are as follows : (*a*) Territorial area and population as in 1913 and in 1927 for 22 Countries ; (*b*) Apportionment of areas, agricultural production and numbers of live stock in 1926 and 1927 for 47 countries ; (*c*) Area, production and yield per hectare for 85 agricultural products for all countries (averages for 1909-1913 and 1924-1927 respectively) ; (*d*) Numbers of the nine principal species of live stock for various countries ; (*e*) Data of imports and exports relating to 40 vegetable and 5 animal products for various countries ; (*f*) Prices for all the chief agricultural products ; (*g*) Ocean freight rates for cereals and cotton ; (*h*) Production, trade and consumption of chemical fertilisers ; (*i*) Rates of exchange.

The statistical tables are elucidated and explained in an introductory chapter and the work as a whole will be found to be not only of great practical interest to persons directly occupied in agriculture, trade and finance, but also of very real assistance to all students of world economic problems as they present themselves to-day.

Microchemical changes in sugar confectionery and in flour confectionery, especially those undergone by the glutenous constituent, are the subject of an article by Mr. James Scott in the *Irish A.M.C.T. Gazette* for September.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

34,685.—Caro, N.—Production of hydrocyanic acid. November 24th.

34,426.—Dutoit, P.—Manufacture of pensulphide of phosphorus. November 22nd.

34,076.—Appareils et Evaporatenrs Kestner. — Production of nitrate of ammonia. November 20th.

Specifications Published.

300,538. Macallum, A. D.—Synthesis of aromatic arsenic compounds containing iodine.

Abstract Published.

298,240.—Synthetic drugs. — I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Salts of aromatic bases are prepared by combining the base with an hydroxylated-diarylketocarboxylic acid, either by melting the components together, or by interaction in molecular proportions in an organic solvent, or by double decomposition of their soluble salts. The products possess therapeutic properties. Examples are given of the combination of 3-henyldihydroquinazoline with *p*-hydroxybenzoyl-*o*-benzoic acid, 2 : 4-dihydroxybenzoyl-2[1]-benzoic acid, and 4-hydroxynaphthoyl-2-benzoic acid. The salts of hydrastinine, orexine and quinine with the above and similar acids are also referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SOLBATCH.

492,711.—Chemical substances in class 1, for making batching oil soluble in water, for use in the manufacture of jute, flax, hemp, cotton and wool. —Hendry Roberts Hills, 16, Camac Street, Calcutta, India. November 28th.

GLYPHONY.

494,836.—Chemical substances in class 1, for use in the manufacture of insulating enamels, insulating varnish, and or substitutes for shellac, ebonite or resin. — The British Thompson-Houston Company, Limited, Crown House, Aldwych, London, W.C.1. November 28th.

DRYVAR.

495,459.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—Agnes Harland Peck, trading as Wm. Harland & Son, Phipps Bridge, Merton, London, S.W.19. November 28th.

BLUNDOLENE.

496,361.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—Blundell, Spence & Co., Limited, 9, Upper Thames Street,

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A NEW METHOD FOR THE PREPARATION OF CUPROUS SULPHATE.

By J. G. F. DRUCE, M.Sc.(Lond.), R.Nat.Dr.(Prague), F.I.C., AND G. FOWLES, M.Sc.(Lond.), A.I.C.

The existence of cuprous sulphate, Cu_2SO_4, has been known for a long time. Joannis[1] in 1897 succeeded in preparing double compounds of the salt with carbon monoxide and ammonia although he failed to isolate cuprous sulphate itself. In 1906 F. Foester and F. Blankenberg[2] adduced evidence that the equilibrium,

$$Cu + CuSO_4 \rightleftarrows Cu_2SO_4$$

represented the facts under certain conditions and they imagined that with water cuprous sulphate was hydrolysed to cuprous oxide and sulphuric acid. They also isolated an unstable compound, $Cu_2SO_4.4NH_3.H_2O$.

Cuprous sulphate itself was first prepared in 1909 by Recoura[3] who obtained it by the interaction of methyl sulphate and cuprous oxide at 160°C.

We have now obtained it in a more simple manner by the interaction of copper and concentrated sulphuric acid :—

$$2Cu + 2H_2SO_4 = Cu_2SO_4 + 2H_2O + SO_2.$$

This reaction has already been investigated[4] and the results given in the *Chemical News*. The presence of cuprous sulphate among the products formed when sulphuric acid acts upon copper was first noticed by Cundall[5], although van Sluiter[6] had previously shown that a powerful reducing agent was present for the solution was able to reduce nitrobenzene to aniline. Cundall proved the presence of cuprous sulphate by filtering the liquid through glass wool and allowing the filtrate to fall into water when the decomposition

$$Cu_2SO_4 = Cu + CuSO_4$$

took place.

We have found that the best yield of cuprous sulphate is obtained by carrying out the reaction between 180-220°C. Concentrated sulphuric acid is heated to about 200° and copper turnings are added. There is a violent reaction and some sulphur dioxide is disengaged. Most of the cupric sulphate formed sinks to the bottom of the liquid in the anhydrous condition. It has *previously been stated*[7] that cupric sulphate is insoluble in concentrated sulphuric acid. This salt is not present at this temperature in any quantity, however, so long as any metal remains undissolved. The acid assumes a bright emerald green colour unless black cuprous sulphide is produced,

which masks it. Whilst still hot the mixture is filtered through a small wad of asbestos into a mixture of equal volumes of dry alcohol and ether which removes the excess of acid. As the filtrate drops into the organic liquid, crystals of cuprous sulphate separate out. These are left on decanting the liquid and are washed with the solvents, drained and dried in a vacuum desiccator.

On analysis 0.2780 gr. of the substance gave 0.3071 gr. $BaSO_4$.SO_4 per cent. 45.5; Cu_2SO_4 requires 42.87 per cent.

Methyl alcohol may also be used instead of the alcohol-ether mixture.

Cuprous sulphate is an almost white solid, which decomposes in moist air with the formation of cupric sulphate together with free copper or cupric oxide, turning greenish or greyish blue. It dissolves in warm concentrated sulphuric acid but is only slowly dissolved by dilute acids with the formation of cupric salts.

When benzene was tried instead of alcohol and ether in the separation of cuprous sulphate the product blackened rapidly.

An attempt was made to prepare the compound obtained by Foerster and Blankenberg, but the deliquescent substance obtained did not correspond with their cuprous sulphate ammonium compound.

It was thought that cuprous chloride and iodide, when acted on by sulphuric acid might yield cuprous sulphate, but neither haloid has been found suitable for making the sulphate. In both instances a good deal of insoluble anhydrous cupric sulphate separated out.

With cuprous chloride the reaction appeared mainly to follow the course:—

$$2CuCl + 3H_2SO_4 = 2CuSO_4 + 2HCl + 2H_2O + SO_2$$

Similarly with the iodide cupric sulphate, iodine and sulphur dioxide were observed but no hydrogen sulphide was detected in the gases evolved so that the reaction may be represented by the equation:—

$$2CuI + 4H_2SO_4 = 2CuSO_4 + I_2 + 2SO_2 + 4H_2O$$

Souberain[8] had shown as early as 1832 that the reaction followed this course.

The cuprous iodide used in these experiments was made by precipitating cupric sulphate solution with potassium iodide and then repeatedly washing the precipitate with potassium iodide solution to remove undissolved iodine. The potassium iodide was afterwards removed with water.

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[2] F. Foerster and F. Blankenberg, *Ber.*, 1906, XXXIX, 4429.

[3] A. Recoura, *Comptes Rendus*, 1909, CXLVIII, 1105; *The Chemical News*, 1909, XCIX, 288.

[4] J. G. F. Druce, *ibid.*, 1928, CXXXVI, 81.

[5] J. Tudor Cundall, *J. Chem. Soc.*, 1914, CV, 60.

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[7] G. Fowles, *School Science Review*, 1927, 84.

[8] E. Souberain, *Journ. Pharm.*, 1832, XIII, 427.

U.S. BUSINESS AND "RATIONALISATION."

AMALGAMATION OF BIG CHAIN DRUG STORE SYSTEMS.

In an effort to swell the ever-increasing tide of American business prosperity, industrial leaders in the United States are applying the principle of rationalisation to every possible branch of industry and commerce. This year has been notable for many mergers, including far-reaching amalgamations in the motor-car, artificial silk, steel and coal industries. Even in the conservative business of banking, important consolidations have taken place.

On 10 December the merger was announced of three of the biggest U.S. chain store systems. The interests controlling the United Cigar Stores system and the Whelan Drug Company, which is one of the largest operators of drug stores in America, have now concluded arrangements to add to their huge organisation a chain of 67 stores operated by the Neve Drug Stores Inc., another famous chain store system.

As a result of the new arrangement, the Neve Drug Store chain will become a unit in the nation-wide United Cigar Stores organisation, although continuing under separate management. The directors state that the facilities for distribution and centralised buying which membership in the larger organisation affords, will mean much more economical operation throughout the system, as well as cheaper prices for the public.

Indications that the scheme will be approved have already been received from a substantial number of the larger shareholders of the Neve Drug Stores, who have agreed to deposit their stock with the Equitable Trust Company for conversion purposes.

PAPER PULP AND CELLULOSE FROM THE EUCALYPTS BY THE SULPHITE PROCESS.*

By L. R. Benjamin and J. L. Somerville, B.Sc.

Introduction.

The present publication deals with the problem of applying the sulphite process to the pulping of the eucalypts, and presents the results of investigations carried out during the past four years.

The precedence in point of time accorded earlier soda pulping investigations was based entirely upon the fact that the "hardwoods" are seldom pulped by any other than alkaline processes. In this connection it may be added that, by whichever process hardwood is pulped in other countries, the product is almost invariably soft, bulky, and of low strength, its use being confined almost entirely to the manufacture of book papers in which the relatively high proportion of longer-fibred sulphite pulp from softwood is relied upon to impart the desired strength. In other words, hardwood pulp is used abroad as a filler for imparting softness and opacity. Pulp of good colour and high strength can be obtained from the eucalypts by a suitable modification of the soda process, followed by proper bleaching and beating. The experience thus gained has been of considerable value in the planning and conduct of the present investigation, one of the principal objects of which has been to find those cooking conditions that would give pulp possessing good strength and a colour sufficiently white, without bleaching, to be used, either alone or in high proportion, in the manufacture of newsprint. Other aspects have also been considered, such as the production of high-grade cellulose for use in the manufacture of artificial silk, but work in this direction has been restricted and mostly controlled by the necessity or desirability of acquiring evidence in support of certain trends, or of collecting incidental information that might be of value in establishing the proposed Australian newsprint industry.

The chemistry of the sulphite process, even at the present time, is incompletely understood, and there are many points connected with its application to the pulping of the eucalypts that would undoubtedly repay thorough investigation if the industry already existed in Australia, but in planning the present research it was considered that the elucidation of these finer points, which perhaps might lead to increased efficiency, and possibly to the production of important by-products, should be left for the time being. The investigation has, therefore, been concentrated upon developing methods that would permit of ready application and be sufficiently economical to aid materially in the early establishment of the sulphite pulping industry and the production of newsprint.

The problem, then, which has to be solved before newsprint can be manufactured in Australia is the finding of a substitute for mechanical pulp that will compare favourably with it in papermaking quality and in price.

In regard to quality, it is possible to produce from the eucalypts bleached soda pulp much superior in quality to groundwood, and the indications were that on a large scale this pulp could be made at a cost not very much in advance of the latter.

Preliminary investigations with the sulphite process pointed to the possibility of cheapening production to the required degree, and subsequent systematic study of the process has practically assured this, for it is now evident that bleaching can be eliminated and a pulp produced so much superior in quality to mechanical pulp, that the admixture of longer fibre for conversion into newsprint will probably not be necessary. Hence, as far as the production of a suitable substitute for mechanical pulp is concerned, the results of the present investigation indicate that this is entirely feasible.

Apart from the demand for newsprint in this country, there is a large consumption of the better grade printing papers and writing papers in which high-grade sulphite pulp is used. In addition to this, there is a very heavy and increasing demand for artificial silk both in yarn and in the form of piece goods. These facts should stimulate the production of high-grade bleached cellulose once a newsprint industry relying on sulphite pulp is established. Accordingly, when it was found that the cooking conditions required for producing pulp sufficiently white in the unbleached state to be used in newsprint also closely approached those necessary for the production of high-grade cellulose, the opportunity was taken of exploring the possibilities further. As a result, considerable information on the physical qualities of the pulp and the chemical purity of the cellulose produced in this investigation has been collected, and is now placed on record.

* Abridged from *Bulletin 87 of the Australian Council for Scientific and Industrial Research.*

EARLY WORK.

The application of the sulphite process to the pulping of eucalypts has never been previously studied in Australia.

The preliminary work was done upon mountain ash (*E. regnans*) Victoria, stringy-bark (*E. delegatensis*) Tasmania, beech (*Fagus Cunninghamii*) Tasmania, and *P. insignis*. The results, even in these early stages, were sufficiently suggestive to cause the interest already centred in soda pulp for newsprint to be diverted to sulphite pulp. So much so, in fact, that large scale tests were carried out in Europe in March, 1924, on behalf of Amalgamated Zinc (de Bavay's) Limited with a view to checking the laboratory work and ascertaining the possibilities of converting the pulp into newsprint, the services of the officer-in-charge of the investigation (L. R. Benjamin) being loaned to the company to assist in the work. The results of these mill-scale tests, as far as they went, were satisfactory, but the need for further investigation was indicated. The experience gained in the conduct of these tests has been of great value in planning and carrying out the latter part of the present investigation.

THE SULPHITE PROCESS.

In the sulphite process the principal active constituent of the cooking liquor is sulphurous acid, the action of which is controlled by lime or other bases present as bisulphites. The liquor throughont the cook is acid, whence the title " acid process," in contradistinction to the soda and sulphate or " alkaline processes."

From this importance difference in the nature of the cooking liquors arise many differences in the character of the pulps produced, and in the construction of the digesters and other equipment. While in consequence of this difference it is not possible to make as pure a cellulose from spruce and other high-grade coniferous pulpwoods by the ordinary alkaline processes as it is by the sulphite process, it has been found that the eucalypts dealt with in this Bulletin are equally amenable to treatment by both the alkaline and acid processes.

The source of sulphur dioxide may be either pyrites or mineral sulphur, the choice being governed by economic factors, but the use of either is dependent on the necessity of keeping the sulphite cooking liquor free from compounds of the element selenium, which catalyse an extremely undesirable by-reaction. The oxidation of the sulphur or pyrites is performed in burners or roasters similar to those used in other industries, and the burned gas, after the removal of dust and sulphur trioxide by washing with hot water, is forced up a tower filled with limestone, down which water flows. To complete the absorption of the sulphur dioxide, the gas delivered from the first tower is forced up a second similar tower, and the weak liquor obtained from the second is sent down the first. The lime goes into solution as bisulphite, and the exhaust gas is composed of nitrogen from the air admitted to the burners and carbon dioxide freed from the limestone. In summer time the water may not be cool enough to absorb the sulphur dioxide sufficiently rapidly, and it is sometimes cooled artificially. It follows that since in this system absorption is more rapid when the inlet gas is comparatively rich in sulphur dioxide, a given tower will have a greater capacity when sulphur instead of pyrites is the source of sulphur dioxide. In the latest types, the acid towers are constructed of ferro-concrete with an acid resisting tile lining. Dolomitic limestone may be used with satisfactory results, but in practice a high calcium limestone is most generally used. The advantages of soda as the base are completely offset at the present time by the difficulty and the high cost of its recovery from the spent liquors after cooking.

The prepared liquor is caused to react with the wood chips by heing heated under pressure in large digesters holding up to 30 tons of chips. On account of the acidity of the liquor, the digesters are lined with bricks of a special composition, while steel is used for the shell to give adequate strength. Lead and special bronzes are used for pipes, valves, and other fittings.

The contents of the digester are always heated with steam, either by the use of a steam coil of lead placed inside the digester or by passing live steam directly into the charge.

The cooking liquor, being a solution of calcium or magnesium bisulphite with sulphurous acid and sulphur dioxide, when heated to the temperature used in cooking, i.e., 135 -150° C., liberates a considerable amount of sulphur dioxide. As the temperature rises the displaced sulphur dioxide and the steam give rise to pressures greater than the digester will safely resist. The maximum pressure employed in practice is from 75 to 90 lb. per square inch, according to the size of the digester, the excess gas pressure being relieved as it is generated. The gas thus obtained is absorbed in the weak liquor from the " acid " towers to increase and

regulate its content of sulphur dioxide. The lime content of the liquor is regulated by altering the rate of flow of the gas and circulation of liquor in the " acid " tower.

The properties of the pulp produced are governed by varying such factors as temperature, time, and composition of cooking liquor. The strongest and best pulp from softwoods is generally obtained by the Mitscherlich process, in which relatively weak cooking acid, containing 2.8 to 3.8 per cent. of sulphur dioxide and about 1.1 per cent. of lime, is used in a cook lasting from 16 to 24 hours and reaching a maximum temperature of 135° C. It is possible to decrease this time greatly, *viz.*, to 8 or 9 hours, as in the " quick cook " process in which stronger liquor containing from 4 to 6 per cent. of sulphur dioxide and higher final temperatures—150-155° C—are applied.

When cooking conifers, the lime consumed varies over a wide range (3 to 7 per cent.) of the weight of wood cooked, and it all goes into the waste liquors of the plant. Of the much more valuable constituent of the cooking liquor, sulphur dioxide, about 110-180 lb. per ton of wood is lost in the waste liquors, while the remainder of the amount initially charged into the digesters is recovered from the relief gases and used again. These variations in lime and sulphur consumption are in large measure due to the different conditions of cooking adopted to produce pulps having a wide range of strength, purity, and other properties. The " quick cook " process, for instance, much used in North America for both newsprint grade and bleached spruce sulphite pulps, shows high lime and sulphur dioxide consumption, because strong liquors and high temperatures are used in order to reduce the time of cooking to a minimum. The eucalypts, as will be seen later, seem to consume more sulphur dioxide than the conifers used in Europe and North America, a fact which may he due to a difference in the precise chemical nature of the lignins of the two classes of wood. The consumption of lime, on the other hand, covers about the same range.

All woods consist, chemically, of three main substances—cellulose, hemicellulose, and lignin, all of which are present in the unit of wood structure, the wood fibre, in approximately the same proportion as in the wood itself. Since the structural base of the fibre is the cellulose, the properties of the paper depend largely upon the physical and chemical properties of the cellulose product resulting from the cooking treatment. Thus, to make a high-grade white paper, the fibre must be practically pure cellulose and the purification must be carried out with considerable care both during cooking and in the after treatment (bleaching) in order to minimise reduction in strength. On the oher hand, in the manufacure of strong wrapping paper, the degree of purification is of much less importance than the preservation of the maximum strength of the fibre.

Experience has shown that, in order to make easy bleaching pulp(purification of the cellulose by cooking must be carried on until the yield of pulp is at most 90 to 92 per cent. of the amount of cellulose in the wood. The eucalpyts mentioned in this report contain from 57 to 62 per cent. of cellulose, and yield up to 58 per cent. of bleachable pulp. The rest of the wood, which is dissolved by the cooking liquor, is lignin and hemicellulose; of these materials, the more important is lignin, because it alone imparts colour to the pulp.

The main reaction by which the lignin is rendered soluble during cooking by the sulphite process is one of sulphonation at unsaturated groups and at aldehyde or ketone groups in the lignin molecule. The lignosulphonic acids thus formed appear in the spent liquor as calcium salts. The action is dependent on the entry of the liquor into the chips, and, in practice, one and a half to two hours is the minimum time taken in heating the charge to 110° C. in order to allow this penetration to take place. From this stage onwards, solution of lignin is rapid. It is converted, while still in the fibre, into lignosulphonic acid, the subsequent solution of which is aided by the hydrolytic action of the hot acid liquor.

Concurrently with the removal of the lignin, the hemicelluloses are being hydrolysed into various types of sugars which are readily soluble and appear in the spent liquor. These have been made, in the past, under the necessary economic stress, a source of ethyl alcohol, but under present conditions the process is economically impracticable in most countries.

This hydrolytic action on the hemicellulose is also exerted on the cellulose itself, and although the latter is sufficiently resistant in normal cooks to retain a useful strength, certain conditions may arise which will attack the cellulose to such a degree as to render the pulp useless for papermaking. These conditions are those that result in the so-called " burnt cook." The progress of reactions resulting in " burning " is not completely understood, but the important

stages are known. The initial acidity of the liquor regularly employed in sulphite cooking is fairly low (pH=2.0) because of the lime present, but it gradually increases during the cook as the lime combines to form slightly ionised calcium lignosulphonates so that, at the end of a normal cook, the acidity may be as high as pH=1.2. At the temperature used in cooking, auto-reduction of sulphur dioxide may proceed slowly even in the normal liquor, a general equation being—

$$3\ SO_2 = 2\ SO_3 + S$$

thionic and thiosulphuric acids usually being formed as well as sulphuric acid. As these are all stronger acids than sulphurous, they decompose the bisulphite until the base has nearly all reacted. When this happens, the rate of formation of the strong acids increases, thus automatically building up the acidity. Direct evidence of the presence of sulphur under these conditions has been obtained consistently in this laboratory. In every case where "burning" has occurred, the dome of bronze digesters or the bronze fittings of lead lined digesters have been covered with a coating of blue sulphide of copper, very similar in appearance to the mineral covellite. This rise in acidity can only be controlled and kept within the desired limits by providing a sufficient amount of lime throughout the cook.

It has been found that the speed of the reaction producing sulphuric acid is enor*mously increased by the catalytic action* of selenium compounds, even in the presence *of the maximum amounts of lime possible*; it is, therefore, of the greatest importance that this element should be absent from the cooking liquors. The control of cooking in *practice is still largely performed* by matching samples of liquor, periodically withdrawn from the digester, with standard solutions of coffee infusion. This method *no doubt functions fairly satisfactorily* when using the same class of wood and making the same grade of pulp year in and year out, but it is significant that where really high *quality pulps are made for the* market, chemical control is employed. This is usually based on analyses made of the cooking liquor at half-hourly intervals. The *most important point* watched is the lime, or "combined SO_2" as it is termed in the mills. Investigation of the pulping of the eucalypts indicates that even better *control than is thus afforded* could probably be obtained if a rapid method for determining the reducing sugar content of the liquor were available. The reason for this is that the strength and beating qualities of pulp from these woods are extraordinarily affected by the reaction that produces sugar.

When digestion of the wood is complete the contents of the digester are either discharged under pressure, and the pulp drained and washed in the "blow pits," or else the digester is cooled below 100° C., the spent liquor withdrawn, and the cooked product washed *in situ*. In the latter case the cooked wood still retains its chip form, and, when finally discharged by evacuation, has to be disintegrated in apparatus specially designed for the purpose. This method, which is employed throughout Europe, obviously calls for a greater number of digesters than are required in mills where the digester contents are blown, and both discharging and disintegration thus simultaneously effected.

The final stages of the process consists of suspending the crude washed pulp in a large volume of water, usually about 100 gallons to 2 to 5 lb. of dry material, and then screening out the oversized material, the size of screen slots or perforations being determined by the grade of pulp required, *i.e.*, the better the grade the more rigorous the screening. If the screened product is to be used directly for conversion into paper, it is *first thickened to 5 per* cent. or 6 per cent. consistency, and then sent to the beaters, where it is subjected to the requisite "milling." If, on the other hand, it is to be *shipped, the pulp is first thickened and then* made into a heavy pulp board, which is *either sold moist or else dried in a continu*ous web on steam-heated cylinders, cut into *sheets or " laps " and baled for transporta*tion.

Owing to the colloidal properties of cellulose, the conditions under which pulp is *dried as well as the extent to which dehydra*tion takes place, have an important influence on its subsequent behaviour in the papermaking process, and consequently *upon the physical properties of the* paper into which it is made. This factor is, therefore, of first-rate importance to users of dried pulp, and it is one of the principal causes of the *differences often* found in papers that are supposed to be of the same grade and quality.

(*To be continued.*)

CHEMICALS AT THE B.I.F.

Chemical exhibits at the 1929 British Industries Fair will again be housed in Hall K at the White City. They *will cover all* branches of the industry, and they will afford convincing proof of the wonderful progress that has been made by British manufacturers.

GENERAL NOTES.

THE COLLEGE OF AGRICULTURE, KYOTO UNIVERSITY, JAPAN.

The above Institution has published the following papers of chemical interest :—

Memoirs No. 2. November, 1926; 1st issue for Agriculaural Chemistry.

K. Kondo, and Hayashi, T.—Studies on proteins. IV. On the preparation of rice-glutelin. Pp. 17.

K. Kondo, and Hayashi, T.—Studies on proteins. V. On the point of optimum flocculation of rice-glutelin. Pp. 15.

K. Koudo, T. Hayashi and T. Matsushita.—Studies on proteins. VI. The influence of salt on the point of optimum flocculation of rice-glutelin. Pp. 11.

K. Kondo, and Hayashi, T.—Studies on proteins. VII. On the refractive indices of protein solution. Part I. Pp. 12.

Memoir No. 4. November, 1927.

M. Shikata.—Researches on the electrolytic reduction potentials of organic compounds. Part I. General introduction to the polarographic method. Pp. 8.

M. Shikata and I. Tachi.—Researches on the electrolytic reduction potentials of organic compounds. Part II. Reduction potential of isovaleraldehyde. Pp. 10.

M. Shikata and I. Tachi.—Researches on the electrolytic reduction potentials of organic compounds. Part III. Reduction potential of pyridine. Pp. 15.

M. Shikata and I. Tachi.—Researches on the electrolytic reduction potentials of organc compounds. Part IV. Reduction potential of nicotinic acid. Pp. 14.

M. Shikata, I Tachi and N. Hozaki.—Application of the polarographic method. Part I. Application on the analysis of abnormal mineral constituents. Pp. 9.

M. Shikata.—Application of the polarographic method. Part II. On copper complex salts. Pp. 16.

M. Shikata and K. Shoji.—Application of the polarographic method. Part III. Application to the microanalysis of reducible substances in fermentation products. Pp. 17.

Memoir No. 5. September, 1928.

K. Kondo, and Hayashi, T.—Studies on proteins. VIII. The influence of salts on the iso-electric behaviour of the protein. Pp. 29.

K. Kondo and T. Hayashi.—Studies on proteins. IX. On the iso-electric point of glutenin. Pp. 17.

CANADIAN CHEMICAL NOTES.

Coal Production.

During the first nine months of the current year, 12,488,321 tons of coal were produced in Canada, the output being 17 per cent. in advance of the average for the corresponding period in the five preceding years. Coal output during September reached 1,395,753 short tons, a decrease of 9 per cent. from the August production at 1,535,065 short tons, but an increase of 14 per cent. over the 1,339,422 tons produced in September, 1927.

Mercury Deposits.

Report No. 687, just issued by the Mines Branch of the Dominion Department of Mines at Ottawa, contains two papers by Mr. V. L. Eardley-Wilmot, one entitled "Notes on the quicksilver occurrences in Canada" and the other "Notes on the occurrences, metallurgy and uses of quicksilver."

According to the first of these reports, the increase in the price of quicksilver during 1926 led to some activity in the mining of Canadian mercury ores. An investigation was therefore undertaken by the Dominion Department of Mines in order to ascertain the possible sources of supply and the latest processes for the recovery of the metal.

The only quicksilver deposits known in Canada which have been operated in the past occur on the north shore of Kamloops Lake, B.C., along a belt some 25 miles in length. The principal deposits are at Copper Creek Station on the Canadian National Railway line, about 5 miles east of Savona, at which point the ore zone is about three miles in width. The cinnabar occurs mainly in numerous scattered narrow dolomite veins, carrying also quartz and calcite. In places these veins carry up to one inch of solid cinnabar, with an average content in the neighboursood of 1 per cent. Some of the cinnabar is associated with stibnite.

A deposit of quicksilver ore occurs also on an island near Sechart, on the west coast of Vancouver Island, and native mercury has also been identified in varions other localities in the Province of British Columbia.

Quicksilver is also said to occur at Groundhog Lake, north-west of Sudbury in Northern Ontario, and traces of mercury occur in the South Lorrain and Gowganda metallic silver.

GOLD.

Canada's gold mining industry comprises two main divisions: the winning of placer gold, or "The Alluvial Gold Mining Industry," and the recovery of gold from auriferous quartz, which falls under the title "The Auriferous Quartz Mining Industry." Gold is, however, often associated with other metals, and particularly with copper, and the Report therefore includes a review of what is described as "The Copper-Gold-Silver Mining Industry."

The total production of gold in Canada last year amounted to 1,852,785 fine ounces, valued at $38,300,464, as compared with 1,754,228 fine ounces, valued at $36,263,110 in 1926.

ASBESTOS.

In 1925 Canada produced 80.6 per cent. of the world's supply of raw asbestos, whilst her chief competitor, Rhodesia, produced 11.3 per cent. All the asbestos at present mined in Canada comes from Quebec, although in 1924 a small production was reported from McKay Lake, near Timmins, in Delora Township, Ontario. The total production of Asbestos in Canada up to the end of 1925 had reached 2,908,456 tons, valued at $123,644,496.

SOAPSTONE.

A paper by Mr. Hugh S. Spence on "Canada's Soapstone Industry" has just been issued by the Mines Branch of the Dominion Department of Mines. Production of soapstone in 1926 took place at two localities, one Eagle Lake (in the Lake of the Woods area, Ontario); and Leeds Township (in the Eastern Townships of Quebec). Canadian pulp mills are estimated to use in the neighbourhood of 2,500 tons of soapstone per annum, the stone being utilised as sawn blocks or bricks for lining the furnaces and driers used in the recovery of the alkaline liquor from the deposits. Production has grown from an initial output of 167 tons in 1922 to 1,411 tons in 1927.

IODINE AND LIVESTOCK.

Frank Ewart Corrie, B.Sc., has written an interesting pamphlet on the above subject. The following is the Foreword by the Author:—

"The significance of the 'mineral' elements—lime, phosphorus, potash, iodine, iron, etc.,—in nutrition is indicated by Forster's experiment, in which animals deprived as completely as possible of these substances in their food died sooner than *corresponding animals deprived of food altogether.* The relative importance of iodine amongst the mineral elements is suggested by the fact that Nature has evolved a special gland for its utilisation; the secretion of the thyroid gland, which besides regulating the metabolism of the human and animal body is its main defence against disease, is two-thirds iodine.

Iodine seldom occurs in abundance except *in some coastal soils; it is a rare element* and is growing scantier. We maintain to some extent the calcium-content, the phosphorus-content, the potassium-content, of our vegetable food-stuffs by manuring our fields with lime, phosphates and potash, but except where guano or Chilean nitrate of soda is used no iodine is restored to the soil, which, with every animal sent to the abattoir, grows consequently poorer and poorer in this *absolutely vital* element.

Moreover, throughout the world there are vast tracts of land which in past ages were robbed of their iodine-content by glacial action and other natural agencies, and which, at any rate since farming began, have never contained sufficient for the maintenance of ordinary health. Australia as a whole is naturally iodine-deficient; so is New Zealand; so also are Canada, the northern tier of the United States, practically all *Africa, Palestine, Mesopotamia,* many districts of India, the cattle country in Brazil and most of Mexico. It is fairly certain that in Argentina the *campo* was once rich in iodine, but in the last three or four decades it has been literally eaten out of the soil.

The research work which, subsidised largely with State funds and organised with exceptional ability and thoroughness, is proceeding intensively in all parts of the British Empire has demonstrated beyond doubt that the lack of iodine in soils is of itself responsible for a great deal of the malnutrition, the stunted growth, the failure to reproduce and the susceptibility to disease which have militated against the prosperity of the livestock industry. The writer has attempted to show, by a study of the diverse functions of the iodine in the body, the reasons for these ills and how they may be prevented. If he can give further information privately on the subject he will be pleased to do so."

ENGLISH SILVER AND ITS FUTURE.

Mr. Omar Ramsden, R.M.S., recently read a paper before the Royal Society of Arts, which concluded as follows :—

It may be true, as some writers would have us believe, that we are groping out to the beginnings of a new style, and therefore must go back to the crude ideas of prehistoric man. I will not say "cave man," because some of the finest examples of pure line drawing are the work of what we call "cave man," and the work of the savages of the South Seas—chip carving, mat weaving and the like—is really extremely beautiful, considering the circumstances under which it is made, and used.

Above all, yet us beware of judging a work by its price. Let us not think a picture or a bowl is the more beautiful because clever dealers have forced its auction-room value up to colossal sums. Beauty is a thing apart from price; which depends upon rarity and artificial forcing.

A set of the "Holy Grail" tapestries were recently sold at auction for some eight hundred pounds, well under one hundred a piece—this one of the lovliest creations of modern times. Burne-Jones does not happen to be in fashion. One day it will sell for fifty or a hundred times that amount. But its delicate beauty will be the same as ever, no matter its price at the moment.

A thing of beauty must be well made in addition to being well designed. On this point we can, in the long run, trust the latent feeling for good work which is native to our northern peoples. It was doubtless this Nordic spirit of beauty which led Willilam Morris to revolt against his surroundings and to create his "earthly paradise," not only of poems, but of visible forms of applied art, and to initiate the present-day ever-growing productions of art work in which real beauty is present in ever-increasing volume.

There is, indeed, a danger of this fine movement being side-tracked by the present vogue for ugliness as a cult, but I have faith in the mental balance of the main body of people who will see it is, after all, but an advertising stunt to catch the eye of a world beginning to weary of exotic post-war conditions.

We may never recapture the exquisite, wonderful pleasures which are our birthright and which were enjoyed by all in earlier times, but we must make the effort.

As an extreme example of these mental pleasures of old, of which we have a written record, one may cite the story of François Villon, a poet, of the common people, who relates how, outlawed for some of his many peccadilios, starving, in rags, and with the watch upon his track, he was fain to pause in his flight to admire some piece of Gothic architecture, newly wrought in Paris.

At the other end of the medieval social scale we have great men like Louis XI of France, our Edward VI, and even Henry VIII, all busy with cares of State and family troubles, but all keenly interested in the art of their craftsmen. We have only to add our admiration for the country houses of England and the Burghers' mansions of Germany and Europe generally to see how innate to all, high, low and middle classes, was this great appreciation of beauty—beauty applied to the objects of ordinary use—to realise how full of pleasure their lives must have been.

I recently saw in the old Castle of Shokloster, in the middle of Sweden, a collection of some 2,000 pieces of medieval weapons, not one of which but was a work of art. So even the instruments of murder were produced by artists.

Sic transit gloria mundi. But we must recapture these lost glories of the world if we are to keep our place amongst the great nations many of which are now making fine efforts and with remarkable success.

We Britishers are said to be slow in the uptake, to use an Americanism, but it is usual for us to muddle through somehow to a successful issue. We are plodding along a somewhat dreary road at present and victory is not yet in sight.

CANADIAN MINING NOTES.

Water Power in the Mineral Industries of Canada.

The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has recently issued a bulletin dealing with the use of water-power in the mining and mineral industries of Canada. It outlines the extent and growth of these industries and the distribution and use of water-power in relation to them and briefly describes the principal installations now being used in that connection.

The mining and mineral industries are now established as one of the basic resources of the Dominion; exploration and development are being rapidly extended and very large amounts of power are and will be required for these undertakings. The profitable operation of many mines is only possible when an ample supply of low-cost power can be secured from hydro-electric

sources, so that the relation between the occurrence of mineral deposits and water-power resources is one of great practical importance.

SUCCESS OF CANADIAN AERIAL PROSPECTING VENTURE.

Northern Aerial Minerals Exploration, Ltd., a Canadian Company organised some months back by Mr. Jack Hammell, has concluded its first season's operations and is announced to have made four promising mineral discoveries. The best, in the opinion of Mr. Hammell, is a gold find at Brow Lake, in the Patricia district of Western Ontario. This has been opened up for 1,100 feet and is to be sampled as soon as the aeroplane can be fitted with skis. Another find is copper-lead-silver in the Athabaska Lake region. The other discoveries, the one copper and the other gold, are in localities which Mr. Hammell declines to discuss at the moment.

Northern Aerial Minerals Exploration, Ltd., planes flew over 100,000 miles in the course of the season's work. One hundred men were in the field and it is planned to have more out next year. "It has been a good year," Mr. Hammell says, "and I am thoroughly pleased."

LARGE INCREASE IN CANADIAN NICKEL EXPORTS.

Canada's exports of nickel in October amounted to 8,534,800 lbs., valued at $1,843,965, as compared with 6,874,400 lbs., valued at $1,459,697 in October, 1927. Canada's total exports of nickel in its refined state and in nickel oxide, matte, etc., amounted to 79,813,900 lbs. during the period January 1 to October 31 of this year, as compared with 58,414,100 during the corresponding period of 1927. The export valuation of nickel for the first ten months of 1928 was $17,683,220 representing a gain of $5,128,737, or 40 per cent. on excess of that for the corresponding months of 1927, when exports totalled $12,554,483.

ONTARIO GOLD PRODUCTION.

The Ontaria Department of Mines reports that the production of gold in that Province in October reached a total value of $2,798,427, the highest record for any month of this year with the exception of January. Ore milled during the month totalled 372,349 tons, the total for the ten months ended October 31 being 3,512,510 tons, with a crude bullion output value of $26,546,913. Both Porcupine and Kirkland Lake camps were up in value as compared with September.

During October, producing mines in order of output were as follows :—Porcupine : (8) Hollinger, McIntyre, Dome, Vipond, Coniaurum, Paymaster, Ankerite and March Gold. Kirkland Lake : (6) Teck-Hughes, Lake Shore, Wright-Hargreaves, Sylvanite, Kirkland Lake Gold and Barry-Hollinger.

October receipts of crude bullion at the Royal Mint, Ottawa, from 18 Ontario producers, totalled 117,886 crude ounces, containing 92,479 fine ounces of gold and 15,537 fine ounces of silver having a total value of $1,920,640.

During the ten months ended October 31, 2,650,319 tons of ore were milled in the Porcupine field, with a total crude bullion output of $16,430,384, the corresponding figures for the month of October being 282,352 tons valued at $1,698,122.

In the Kirkland Lake field, ore milled during the ten months totalled 862,191 tons, giving a crude bullion output of $10,116,529. The October figures were 89,997 tons, valued at $1,100,305.

GEOLOGY OF BOSTON CREEK, ONTARIO.

The rocks in Boston Creek area are well exposed and are all pre-Cambrian in age, consisting essentially of Keewatin lavas, tuff, diabase and andesite, all of which are cut by later intrusives, including diorite, granite, porphyry and younger diabase dikes. The Barry-Hollinger Mine is producing gold; No. 7 vein contains mineralised quartz in Keewatin pillow lava, and diabase, and number 5 lies along a fault showing considerable displacement. Gold is found in the quartz in association with chalcopyrite. Diamond drilling is being done on the Boston-McRae, Bennett-Pacaud, Cotter, and Miller-Independence, and on the Hilltop property a quartz vein in Keewatin diabase has been sunk on to a depth of 620 feet. The ore consists of quartz with chalcopyrite, pyrite and chlorite, containing very fine free gold. At the Gold Hill mine gold is associated with chalcopyrite, pyrite and specularite in a quartz gangue, the shaft having reached the 1,000-foot objective. The Ostrom property contains spectacular free gold on the surface, and has sunk to 500 feet. In Skead township the Telluride and Grace Lake gold prospects are under development.

OBA GOLD AREA OF ONTARIO.

Dr. J. A. Maynard, of the Ontario Department of Mines, reporting on the geology of the Oba Gold area in the district of Algoma, says he found numerous bands of schist complex which though narrow are quite favourable for the occurrence of minerals. Native gold associated with galena, pyrite and chalcopyrite occur in several places, the last mentioned mineral being widely distributed throughout the area, occurring mainly in small showings in quartz veins and pegmatite dikelets. These dikes also contain molyhdenite and in places large crystals of white mica. Dr. Maynard states the prospects in general for mineral deposits of economic importance are quite good. The Oba area is in a virgin forest of spruce, poplar, white birch and jack-pine.

SURVEYING IN MANITOBA.

The geological surveying parties of the new Manitoba Department of Mines, which have been in the field since the early summer, have now returned to Winnipeg and it is expected that their reports, accompanied by maps, will be ready for publication by the early part of the winter. A party in charge of Mr. L. Greer, after covering the English Brook area, went north and investigated the district adjacent to the McLachlan River, west of Island Lake. A second party, under Mr. D. J. Birse, spent the early part of the summer in the Cold Lake country and then came back to the Central Manitoba area. Mr. Birse covered the Hav Lake and Long Lake areas and then worked south to Slate Lake and out by way of the Bird River, examining all the operating properties and recent discoveries reported.

MANITOBA MINING PROGRESS.

With the approach of winter, activities at the Flin Flon mine are being restricted and it is expected that the test mill will soon be closed down. Progress in ore testing is reported to have been entirely satisfactory to the engineers, and the company is now concentrating its efforts on the development of a transportation route to the power plant at Island Falls, Sask.

At the Sheritt-Gordon mine development work is going ahead rapidly and a mine of great size has been proved. Shaft sinking done so far is reported to have indicated about ten million tons of ore, diamond drilling having shown widths up to 50 feet with mineralisation in excess of $14 a ton. Diamond drilling work on the Oak claim, to the west of the property, has been very encouraging, indicating that a third shaft will be required with a total length of approximately three miles calling for development. he main deposits are being developed at two shafts 7,000 feet apart covering these deposits to a length of 12,000 feet. Encouraging results are also reported from the diamond drilling campaign carried out during the summer on the Shellett property, about 8 miles east of the Sherrittt-Gordon mine, the programme so far completed consisting of a series of drill holes to depths around 250 to 300 feet with values in copper and gold.

In central Manitoba, development work on the Tene 6 section as well as on the Kitchener property of Central Manitoba Mines, Ltd., is stated to have been extremely encouraging, and approximately $350,000 in gold bullion was despatched to the Ottawa Mint prior to the end of October. The Company expects to complete, during the winter, an aerial tramway connecting the Tene 6 and the Kitchener mill.

Other mines in Central Manitoba respecting which details are given are the Oro Grande, Selkirk-Canadian, Gem Lake, Grand Central Gold and the Montcalm-Tine Mines.

A silver-lead discovery is reported on the west side of Bulldog Lake, six claims having been staked on the property close to the Oro Grande mine. The Consolidated Mining and Smelting Company of Canada, Ltd., are stated to have optioned the Black-Moon group of 25 claims, 1½ miles west of the Cryderman group. Surface showings indicate a silver-lead ore and work will be done during the winter in an effort to prove a commercial ore body.

As a result of the recent discovery of tin in central Manitoba, the Bird (Oiseau) River area is now the centre of a great deal of interest, and large areas have been staked by prospectors, as well as by persons representing larger interests.

NEW ALBERTA GEOLOGICAL REPORT.

The Scientific and Industrial Research Council of Alberta has just issued a copy of Report No. 19, by Mr. Ralph L. Rutherford, dealing with the geology of the area between the North Saskatchewan and McLeod Rivers. This report was prepared during the seasons of 1926 and 1927, and covers an area of appripoximately 5,000 square miles, extending from the North Saskatchewan

River to the Athabaska River and west to Edson. A geological map in three colours on a scale of 1 inch to three miles accompanies the Report.

The object of the survey was to determine and map the area boundaries of the Edson and Paskapoo formations which occur within this area, and to obtain information on the thick coal seams which also occur. Attention was also given to the occurrences of building stone, gravel and placer gold.

RAILWAY BRANCH LINE TO THE SHERRITT-GORDON MINE.

An agreement has been entered into between the owners of the Sherritt-Gordon mine and the Canadian National Railways under which a branch line will be constructed to connect the mine with the new Manitoba Northern Railway (branch of the Hudson Bay Railway). The branch will leave the Manitoba Northern (Flin Flon) line at Mile 51, and proceed 42 miles in a north-westerly direction. Construction is to be begun immediately.

PULVERISED FUEL FIRING.

The Latest Scientific Developments.

A short time ago the International Combustion Engineering Corporation received an order from the New York Edison Company for four gigantic boilers each of 500,000 lbs. evaporation per hour normal duty, with 800,000 lbs. overload, to be fired with " Lopulco " pulverised fuel throughout on the latest principles. This far surpasses in size any existing boilers, and there seems to be no end to developments in steam generation practice. Significant also is the Neasden Power Station of the Metropolitan Railway, London, which is now being completely reorganised on these lines. The plant will consist of 6 of the new " Lopulco " vertical bent tube boilers, fired with pulverised fuel each of 9,050 square feet heating surface, corresponding to a normal evaporation of 80,000 lbs. of water per hour and 100,000 lbs. per hour maximum. These are to replace 20 existing mechanical stoker fired boilers, and the working pressure is 300 lbs. per square inch gauge pressure and a superheated steam temperature of 750° F. Further, air heaters are to be installed without feed water economisers, reducing the flue gas temperature to about 270° F. and delivering heated air to the combustion chamber at approximately 500° F., the feed water being 250° F.

The " Lopulco " pulverised fuel equipment is to be of the most modern 1928 design, the main features being shorter overall height of the setting, the drying of the coal by passing air from the air heaters through the " Raymond " pulverising mills, 6 in number, each with a capacity of 6 tons per hour, and much smaller combustion chambers, due to the use of the new " R " type " Lopulco " pulverised fuel burner on the " turbulent " principles. This enables the combustion to be completed in 10 feet only instead of 30 feet as hitherto required, so that at Neasden only two burners will be required for this very large boiler, situated in front of the combustion chamber instead of over the top, as with the previous " fishtail " burner. Further, the latest design of " Murray-Usco " steel tubes in series with the boiler are being employed for the furnace construction at each side and also at the back, while the front wall with the two burners is not cooled.

The air from the air heater partly discharges through the " Raymond " mills to the " R " burners as primary air, while the remainder goes direct to the burners in the form of secondary air, in both cases the most pronounced " twist " being given in the burner itself so as to give a violent mixing action and extremely intimate contact with the coal and the air. As a result up to 6 tons of coal per hour per single burner can be burnt, this being highly important also for marine and industrial work with cylindrical boilers of the " Scotch " and " Lancashire " types.

Finally, of great interest is the new " Detrick-Usco " hollow air-cooled wall, constructed of interchangeable fireclay blocks or tiles, 30″ high and 12″ wide, supported from behind by means of cast iron hangers suspended from ledge beams to vertical steel bars or rods on the outside of the setting, all banded together at the top by struts. The ledges also carry a thin outer insulating wall, forming a sealed narrow passage or chamber behind the main inner firebrick wall, through which cold air is circulated on the way to the combustion chamber. In this way all the blocks are entirely self-contained and subjected to no stresses and strains, vertically or horizontally, from the adjoining blocks, while a gas-tight and air-tight joint is always obtained because of recessing at the top, bottom and sides, so that there is ample allowance for expansion and contraction without any wedging or compression.

The main advantages claimed for this new method of wall construction include low repair, wear and tear, and maintenance costs, reduced radiation losses, ability to stand the highest temperatures, convenient

supply of preheated air, and much less capital cost as compared with 4″steel fire tube water cooled wools, operating under full boiler pressure, now also being largely used. As to which type of wall is the best depends entirely upon the individual conditions, especially the size of the plant and the method of firing.

Proceedings and Notices of Societies

ROYAL MICROSCOPICAL SOCIETY.

A meeting was held on December 19, when the following papers were read and discussed :—

Some Further Notes on the Pegididæ. By E. HERON-ALLEN, F.R.S., F.R.M.S., AND ARTHUR EARLAND, F.R.M.S.

A New Parasitic Ciliate from the Intestine of the Bengal Monkey (Macacus rhesus). By PROFESSOR E. GHOSH, M.Sc., M.D., F.Z.S., F.R.M.S.

The Annual General Meeting of the Society will be held on 16 January, 1929, when Mr. Josepb E. Barnard, F.R.S., P.R.M.S., will deliver the Presidential Address.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

CONGRESS IN THE CITY OF ZÜRICH, WHITSUNTIDE, 1929.

We have been officially advised that the next Congress of the Royal Institute of Public Health will be held in the City of Zürich during Whitsuntide, 1929, from Wednesday, May 15, to Monday, May 20, on the invitation of the Canton, the Municipality and the University of that city, and under the Presidency of The Lord Meston of Agra and Dunnottar, K.C.S.I., LL.D., Chancellor of the University of Aberdeen.

The Congress will be of an international character and will be conducted in English in the following Sections :—

Section I.—" State Medicine and Municipal and Social Hygiene."

Sectiou II.—" Industrial Hygiene and Industrial Diseases."

Section III.—" Child Welfare, School Hygiene and Women and Public Health."

Section IV.—" Pathology, Bacteriology and Biochemistry."

Section V.—" Tuberculosis."

Section VI.—" Climatology and Sports Hygiene."

Section VII.—" Veterinary Medicine and Meat Hygiene."

The meetings of the Congress will be held in the University of Zürich.

To this Congress delegates are being invited from the Governments, the Municipalities, the Universities, and other public bodies of Switzerland, Great Britain, and Ireland, as well as from France, Italy, the United States of America, etc.

Arrangements for travel and hotels are in the hands of Sir Henry Lunn, 5, Endsleigb Gardens, Euston, W.C.7., from whom particulars can be obtained.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

MANCHESTER SECTION.

A meeting was held at the Milton Hall, Deansgate, Manchester, on December 14. The following paper was read :

Present Day Methods of Oil Extraction. By R. A. BELLWOOD, M.I.Mech.E., M.I.Chem.E.

THE PHYSICAL SOCIETY.

A meeting was held on Friday, December 14, at the Imperial College of Science.

A Lecture entitled " A Survey of Heat Conduction Problems " was given by Ezer Griffiths, D.Sc., F.R.S.

Proceedings at the meeting held on November 23, W. H. Eccles, D.Sc., F.R.S., in the chair :—

The following were elected Fellows of the Physical Society :— Leslie Martin Clark, Joseph Parker Manickasingham, C. A. Luxford.

The President announced that the Council had elected the following Student Members of tbe Society :— Sidney Jefferson, Ronald Curry.

A paper entitled " The Effect of Superimposed Magnetic Fields on Dielectric Losses and Electric Breakdown Strength," by Allan Monkhouse, M.I.E.E., A.M.I.Mech.E., was taken as read, in the absence of the author.

A paper entitled " A New A.C. Potentiometer of Larsen Type " was read by Albert Campbell, M.A.

A paper entitled " Ferromagnetic Ferric Oxide " was read by Prof. E. F. Herroun, F.I.C., and Prof. E. Wilson, M.Inst.C.E., M.I.E.E.

A paper entitled " The Physical Interpretation of Wave Mechanics " was read by G. Temple, Ph.D., 1851 Exhibition Research Student, Imperial College of Science.

A Demonstration of Emulsions showing Chromatic Effects was given by R. H. Humphry, M.Sc., The Sir John Cass Technical Institute.

SCIENCE AND COMMERCIAL PROGRESS.

The claim made for a new type of gas fire radiant that it will impart more of the sun's heat to the energy emitted by the domestic gas fire, received striking confirmation from Professor Leonard Hill, the famous radiologist, who spoke at a demonstration of the new radiant given on November 22, at the Central Research Laboratory of Radiation, Ltd., where it has been evolved after three years of research work.

Professor Hill, in congratulating the chairman of the Company on the results obtained by their laboratory work, said he felt strongly how important it was that there should be behind our great commercial undertakings those laboratories run by qualified scientists to carry out research work in industry. " The progress of commerce," he said, " must depend on the application of scientific knowledge in the highest sense, for it is on this knowledge that success is based."

Dealing with the scientific authority behind the claims made for the new radiant in the thermo-XX-beam fire, Professor Hill described the work carried out by Sonne of the Finsen Institute, which proved that visible infra-red rays gave a higher subcutaneous temperature than that produced by dark-red rays, demonstrating the more penetrative nature of the visible and short infrared ray. It was clear that the new radiant gave out distinctly more of this type of ray than the ordinary radiant, and tests carried out at his suggestion had confirmed the fact and shown that these rays penetrated into the horny layer of the skin, acted upon the nerve ends, and excited sweating, sensible and insensible, with the result that a moist instead of a dry, scorching effect was produced. " I hope," he said, " that the new radiant will increase the comfort of the gas fire and extend its use."

Mr. H. James Yates, Chairman of Radiation, Ltd., who referred to Professor Leonard Hill's independent examination of the new radiant, said their research work in connection with the new thermo-XX-beam radiant, had been brought about by a desire to find whether improvement could be effected in the efficiency of the quality of the energy produced by the gas fire. The new radiant gave far more visible infra-red rays than had been attained hitherto with the gas fire.

" In this phase of our research work," he said, " we are blazing a trail so far as the gas-fire is concerned, and as yet we are, I think, really only on the fringe of this development, which is enabling us to impart more of the quality of the sun's heat to the energy emitted by one of the most important types of domestic heater in use in this country.

" I may perhaps be regarded as not too extravagant if I say that our ultimate ideal is to bring eternal sunshine into every home; and with that sunshine the peculiar qualities of warmth, energy and health, which we in these northern islands so sorely miss at this time of the year."

The demonstration included several tests with the new thermo-XX-beam gas fire, comparison being made with the older type of gas fire. The new radiants gave off a much yellower light, and by means of the injector-ventilator principle, incorporated in the gas fire, perfect ventilation was assured, the air of the room being automatically changed from four to six times per hour.

The new gas fire, with its health-giving radiance, is regarded as a valuable adjunct to the equipment used by those engaged in therapeutic work.

INCREASED PRODUCTION OF NATURAL GAS IN CANADA.

The production of natural gas in Canada during the year 1927 showed an increase of 11.3 per cent., the revised figure just published by the Dominion Bureau of Statistics at Ottawa being 21,376,791 thousand cubic feet worth $8,043,040.

Canada's commercial production of natural gas comes from four provinces, Alberta leading with an output of 13,434,621 thousand cubic feet valued at $3,586,533. Ontario had an output of 7,311,215 thousand cubic feet valued at $4,331,750 and New Brunswick, 630,755 thousand cubic feet valued at $124,637. Manitoba also appears in the Government statistics with 200 thousand cubic feet valued at $60. Average prices per thousand cubic feet for natural gas in Canada were: New Brunswick, 20 cents; Ontario, 59 cents; and Alberta 27 cents.

The Report of the Bureau gives the number of firms engaged in the natural gas industry at 172, this figure not including operators of about 300 privately owned shallow wells. The number of firms increased by three over 1926. Capital was slightly lower at $56,777,091. Employees increased from 1,254 to 1,342 and salaries and wages from $1,448,778 to $1,535,498.

NOTICES OF BOOKS.

Agricultural Research in 1927. Royal Agricultural Society of England. Pp. 190. London: John Murray, Albemarle Street, W. Price 1s. 3d. post free.

The third volume of this annual summary of the scientific and economic research work in agriculture, not only at home but abroad, in so far as colonial and foreign results are of interest to agriculturists in this country, has now been issued. Started two years ago at the instance of the Research Committee of the Royal Agricultural Society, quite frankly as an experiment, the publication seems to have established a definite place for itself in the periodical literature of the farming industry. Farmers are naturally at a disadvantage not only in interpreting the results of scientific work but also in knowing where to look for them. They appear in a great variety of forms, in periodicals not always accessible to the farmer and couched in language not always easily understood by him. His work lies around him on his farm; he has not the time nor always, in these days, the means to study a multiplicity of journals and pamphlets, and thus it happens that the results of research work are often too slow in reaching those who are most concerned to know about them. Collected from all available sources, put together by acknowledges authorities in non-scientific language, the contents of *Agricultural Research* should be studied by all those who wish to keep themselves abreast of the times in modern agriculture.

It is impossible to refer to all the subjects dealt with in this publication. Arable farmers will be interested in the article on varieties of English cereals which forms the opening section of Mr. Engledow's review of "Crops and Plant-breeding," whilst the section on grass mixtures is of particular importance to him at the present time when so much plough land is being laid down. Mr. Mackintosh has some useful notes on the interpretation of milk records, which may be a pitfall to the purchaser of dairy stock if taken too literally and without due allowance for certain important factors. Under the heading of "Agricultural Economics," Mr. Orwin deals with such matters as the economy of baby beef production, whilst this section also contains a brief but useful summary of the economic position and the trend of events in the agricultural industry at the present time. In these days of high labour costs and low prices, the farmer is turning more and more to the use of machinery in the hope of increasing the output of labour, and the information contained in Dr. Owen's contribution on "Agricultural Engineering," dealing as it does not only with the efficiency of old and well-tried implements but also with new inventions such as those for rotary cultivation, the combined harvester, and the potato harvester, will receive close attention. Dr. Crowther, as would be expected, has much to say on recent work in "Animal Nutrition," and "Soils and Fertilisers" form the subject of a valuable review by Sir John Russell. His recent tour of farming in Australia has enabled him to make some interesting comparisons of experiences in that continent. The volume concludes with Sir John McFaryean's summary of the progress of "Veterinary Research" during the year. Unfortunately, a cure for the foot-and-mouth disease scourge is still to seek, but the summary makes it clear that rearch in this as in other diseases is being vigorously pressed. Dairv farmers should study carefully the advice given as to the best methods for combating Epizootic abortion.

For the assistance of students and others desirous of consulting original sources of information, each section of *Agricultural Research* concludes with a complete bibliography of papers quoted. The Royal Agricultural Society, it should also be noted, has reduced the price to 1s. 3d., post free, in order to secure the widest possible circulation.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are pnblished by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

35,220.—Bataafsche Petroleum Maatschappij.—Absorbing ethylene, etc., by sulphuric acid, etc. November 29th.

34,881.—Fletcher, W. — Manufactures of methanol. November 27th.

34,882.—Fletcher, W. — Preparation of hydrogen cyanide. November 27th.

35,397.—Hansen, C. J.—Removal of ammonia, etc., from gases. November 30th.

34,829.—I. G. Farbenindustrie Akt.-Ges. —Treatment of gases containing hydrogen, etc. November 26th.

Specifications Published.

301,000.—Johnson, J. Y. — Manufacture and production of alcohols.

300,946.—Husain, Dr. S., and Partington, J. R.—Production of pseudo-perphosphates.

300,940.—Carpmael, A.—Process for the manufacture of o- and p-xylene.

301,112. Smith, F. E., Desborough, A. P. H., Thomson, W. T., Ledbury, W., and Blair, E. W.—Manufacture of nitroglycerine and the like.

Abstract Published.

298,670.—Iodine—Johnson, J. Y., 47, Lincoln's Inn Fields, London.

Crude nitrate of soda is heated to a temperature of 200-250° C. which is below the temperature at which decomposition of the nitrate occurs. Iodine contained in the crude material is liberated and passes off in the form of vapour of free iodine which may be condensed. Gases or vapours such as sulphur dioxide, nitric oxide, air, water vapour, etc., may be passed over the material to carry over the iodine fume. The residual material may be heated to a higher temperature to form oxides of nitrogen as described in Specification 266,744 or may be treated by leaching or otherwise to separate nitrate.

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Further Government Approval of Lysolats—the recently discovered solid form of Lysol.

It was announced recently that the Rideal Walker Index had proved Lysolats (solid Lysol tablets) to be several times more powerful weight for weight than any Lysol in existence and than the finest carbolic acid.

Now Lysolats have been further tested by the Government Chemist and by the Lister Institute under the Martin-Chick method. It was found that the germicidal coefficient of Lysolats as compared with pure phenol (taken as 1) was 2.8+20%.

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THE COLLINSICS OF MINERALS.—VIII.

By HAWKSWORTH COLLINS, B.A. (Camb.).

Arsenic occurs in each one of the twelve minerals in Table XI. Its relative volume is 19.58, and optical refractivity 17.75. All the other atoms concerned have been demonstrated in previous papers.

A collinsic contains no hypothesis of any kind. Each one is an arrangement of scientific facts in such a manner that the matter is intrinsically proved to be true, and at the same time an enormous amount of new light is thrown upon each atom.

The first line contains the chemical formula of the mineral. The second gives the theoretical specific gravity, and the experimental S.G. The third line gives (between the brackets) the relative volume of each atom; and also the product obtained by multiplying the sum of these volumes by $\mu - 1$, where μ is the refractive index of the substance. The fourth gives the theoretical and also the experimental refractive indices. And the fifth line gives the sum of the optical refractivities of each atom.

Five mathematical operations must have been successfully performed in order to produce any one collinsic :—

(i) The relative volumes of the elements must have been correctly obtained.

(ii) The optical refractivity of each element must have been exactly found.

(iii) The molecular weight, when divided by the sum of the atomic volumes must give an obviously correct theoretical S.G.

(iv) The sum of the atomic volumes, when multiplied by $\mu - 1$, must give a number, which corresponds to at least four figures with—

(v) The sum of the optical refractivities of the atoms of the molecule.

Olivenite (No. 85) will now be taken as an example for the explanation of all collinsics.

An atom of Cu, having the volume 7.13 and O.R. 13.22, occurred in seven minerals in the last paper, and appears in three of the minerals in the Table below.

An atom of As, having the volume 19.58 and O.R. 17.75, occurs 15 times in Table XI.

An atom of oxygen, having the volume 7.53 and O.R. 1.654, has occurred 135 times in these 96 collinsics.

An atom of oxygen, having the volume 4.45 and O.R. 1.747, has occured 86 times in the same.

Oxygen with volume 2.51 and O.R. 1.346, has occurred 692 times.

Hydrogen with volume 5.76 and O.R. 2.613 has occurred 366 times.

When the molecular weight is divided by the sum of the volumes in the third line the result is 4.232, which lies between the experimental values of S.G.

When this same sum is multiplied by $\mu - 1$ the result is 109.423 which corresponds to four figures with the sum of the refractivities of the atoms in the fifth line.

The rel. vol. of crystallised H_2O is $14.03 = 5.76_2 + 2.51$

Its O.R. is $6.572 = 2.613_2 + 1.346$

All impurities of the minerals are evidently eliminated.

The Discovery of the Collinsics is by far the most exact and most extensive discovery which has ever been made, and the solution of the problem depended mainly upon the discovery of the three rel- vols. of oxygen. These volumes have very frequently been proved to be true in the *Chemical News* during the last four years by means of the Law of Heat of Formation.

Although Nos. 91-94 are not minerals, it is evidently correct to include them and all other artificial crystalline substances in this demonstration, since they are of the same nature as minerals.

TABLE XI.

THE COLLINSICS OF TWELVE MINERALS.

			Theor. Column	Obs. Column	
(85)	Olivenite	$Cu_4 + As_2 + O_5 + O_2 + O_2 + H_2O$			
			4.232	4.25	M
				4.135	Herm
		$109.423 = 0.821(7.13_4 + 19.58_2 + 7.53_5 + 4.45_2 + 2.51_2 + 14.03)$			
			1.821	1.772-1.863	S
		$109.408 = 13.22_4 + 17.75_2 + 1.654_5 + 1.747_2 + 1.346_2 + 6.572$			

Theor. Column | Obs. Column

(86) Arsenolite $As_2 + O + O + O$ — 3.7 | 3.7 D

$$40.247 = 0.7502(19.58_2 + 7.53 + 4.45 + 2.51)$$

1.7502 | 1.748–1.755 D

$$40.247 = 17.75_2 + 1.654 + 1.747 + 1.346$$

(87) Haidingerite $H + Ca + As + O + O + O_2 + H_2O$ — 2.844 | 2.848 D

$$46.276 = 0.6647(5.76 + 13.25 + 19.58 + 7.53 + 4.45 + 2.51_2 + 14.03)$$

1.6647 | 1.67 D

$$46.278 = 2.613 + 13.25 + 17.75 + 1.654 + 1.747 + 1.346_2 + 6.572$$

(88) Euchroite $Cu_2(OH)AsO_4.8H_2O$ — 3.385 | 3.389 D

$Cu_2 + As + O + O_4 + H + 3H_2O$

$$73.552 = 0.741(7.13_2 + 19.58 + 7.53 + 2.51_4 + 5.76 + 14.03_3)$$

1.741 | N_g1.733 W

$$73.557 = 13.22_2 + 17.75 + 1.654 + 1.346_4 + 2.613 + 6.572_3$$

(89) Pharmacolite $H + Ca + As + O + O_3 + 2H_2O$ — 2.602 | 2.535–2.64 D

$$49.717 = 0.599(5.76 + 14.54 + 19.58 + 7.53 + 2.51_3 + 14.03_2)$$

1.599 | 1.59 M

$$49.719 = 2.613 + 10.52 + 17.75 + 1.654 + 1.346_3 + 6.572_2$$

(90) Hoernesite $Mg_3 + As_2 + O_8 + 8H_2O$ — 2.546 | 2.6 W; 2.474 D

$$113.922 = 0.5872(7.51_3 + 19.58_2 + 2.51_8 + 14.03_8)$$

| N_m1.571 W

1.5872 | N_g1.596 W

$$113.937 = 5.031_3 + 17.75_2 + 1.346_8 + 6.572_8$$

(91) Potassium arsenate KH_2AsO_4

$K + H_2 + As + O + O_3$ — 2.63 | 2.638 Thom

$$36.155 = 0.5282(22.29 + 5.76_2 + 19.58 + 7.53 + 2.51_3)$$

1.5282 | N_o1.5674 W; N_e1.5179 W

$$36.158 = 7.49 + 2.613_2 + 17.75 + 1.654 + 1.346_3$$

(92) Disodium arsenate $Na_2HAsO_4.7H_2O$

$Na_2 + H + As + O_2 + O_2 + 7H_2O$ — 1.864 | 1.871 Schiff

$$80.098 = 0.4786(11.865_2 + 5.76 + 19.58 + 7.53_2 + 2.51_2 + 14.03_7)$$

1.4786 | 1.4782 C.R.P.C.

$$80.097 = 3.865_2 + 2.613 + 17.75 + 1.654_2 + 1.346_2 + 6.572_7$$

(93) Sodium arsenate $NaH_2AsO_4.2H_2O$

$Na + H_2 + As + O + O_3 + 2H_2O$ — 2.32 | 2.32 Dufet

$$45.677 = 0.5306(11.865 + 5.76_2 + 19.58 + 7.53 + 2.51_3 + 14.03_2)$$

1.5306 | 1.5265 C.R.P.C.

$$45.677 = 3.865 + 2.613_2 + 17.75 + 1.654 + 1.346_3 + 6.572_2$$

		Theor. Column	Obs. Column	
(94)	Sodium arsenate $NaH_2AsO_4.H_2O$			
	$Na + H_2 + As + O + O_3 + H_2O$	**2.526**	2.535	Schiff
	$\mathbf{39.104 = 0.5427(11.865 + 5.76_2 + 19.58 + 7.53 + 2.51_3 + 14.03)}$	**1.5427**	1.5382	C.R.P.C.
			1.5535	C.R.P.C.
	$\mathbf{39.105 = 3.865 + 2.613_2 + 17.75 + 1.654 + 1.346_3 + 6.572}$			
(95)	Higginsite $CaCu(OH)AsO_4$			
	$Ca + Cu + H + As + O_5$	**4.35**	4.33	W
	$\mathbf{50.834 = 0.8535(14.54 + 7.13 + 5.76 + 19.58 + 2.51_5)}$	**1.8535**	N_g1.846	W
	$\mathbf{50.833 = 10.52 + 13.22 + 2.613 + 17.75 + 1.346_5}$			
(96)	Tilasite $Ca + Mg + F + As + O + O_3$	**3.761**	3.77	W
	$\mathbf{39.343 = 0.6665(14.54 + 7.51 + 5.42 + 19.58 + 4.45 + 2.51_3)}$	**1.6665**	N_m1.660	W
			N_g1.675	W
	$\mathbf{39.346 = 10.52 + 5.031 + 0.26 + 17.75 + 1.747 + 1.346_3}$			

M = Miers.
S = Smithsonian Publication.
D = Dana.
W = Winchell.
C.R.P.C. = Chemical Rubber Publishing Co.
N_m = Mean index of refraction.
N_g = Greatest index of refraction.
N_o = R.I. for the ordinary ray.
N_e = R.I. for the extraordinary ray.

Just as the 23 discoveries given in the last paper led to the Collinsics, so the latter will lead to a much deeper knowledge of the Constitution and Structure of Atoms.

These results have been and are being obtained by steadfastly keeping within the thin line of truth which lies in all experimental data, and by refusing absolutely to consider any wild hypotheses.

STARCH.

Dr. R. Weidenhagen has contributed an interesting article on the question of the constitution of starch in the *Zeitschr. Deutsch. Zucker-Ind.*

He deals with the appearance of starch grains in plants and the capacity of the plant cells for its conversion into other carbohydrates, which may probably be explained on grounds of chemical fermentation. He discusses the composition of the starch grain, which he differentiates into: (1) the envelope of amylopectin (α-amylose) which forms about 83 per cent. of the grain and contains phosphoric acid as an ester and yields a violet colour with iodine, and (2) the inner substance or Amylose (β-amylose) which does not form a paste, and contains no phosphoric acid and goes blue with iodine.

The formation of starch is generally explained in accordance with the phenomena of its decomposition. The two most important theories as yet are those of Karrer and Pringsheim, both having this in common that they regard starch as a polymerisation product of relatively low molecular elementary molecules. These so-called basic elements are said to form anhydrides of several glucosidal combined glucose residues. At this point their views diverge with regard to the sugar residues and their interior configurative arrangement. Recently Bergmann has different views on the structure of these complex carbohydrates and introduces the idea of the individual group, which is said to provide the present characteristic basis for the various chemical individual substances. According to this theory the individual groups are not definite substances, but structural elements for the formation of substances and provide by the interaction of themselves according to the different aggregation types the different states of aggregation of one and the same substance. If this is so, the basic

elements of Karrer and Pringsheim, which would appear to be independent, individual substances cannot be identical with the individual group of starch. The individual group must be able to be isolated from the starch complex by complete decomposition and the process must be reversible. Proof of the reversibility of the process is the most important and the hardest to obtain. Bergmann in conjunction with Kuche has obtained demonstration of it in the amylose of potato starch. It follows that the individual group of starch is a glucose anhydride. Starch forms then a highly aggregated glocosan.

An association theory exists in direct opposition to the polymerisation theory and this would entirely alter preconceived theories on the structure of carbo-hydrates and proteins. Dr. Weidenhagen believes that although there remain certain obscure points in the experimental proof of Bergmann's conception, a solution of the configuration problem of starch has been attained.

PAPER PULP AND CELLULOSE FROM THE EUCALYPTS BY THE SULPHITE PROCESS.

By L. R. BENJAMIN AND
J. L. SOMERVILLE, B.Sc.

(*Continued from Page* 390.)

PULP TESTING AND ANALYSIS.

Subsequent to screening, part of the pulp was prepared for analysis, part for bleaching, and part for the processes of beating and papermaking. The paper test sheets were made by laboratory processes in which the aim was to product papers that would give a good indication of the strength and other qualities of the pulp from various cooks and, in general, of the value of the wood under experiment for papermaking.

STRENGTH TESTING.

It is an adage among papermakers that "paper is made in the beater." Though this is only half the truth—for it would be equally correct to say that paper is made in the digester—it was nevertheless of the highest importance to develop beating methods in which all cognate factors were controllable. Practical beating is a mechanical process in which the fibres in suspension in water are individually subjected to cutting, rubbing, and squeezing. The result of suitable beating is to develop the strength and other qualities of paper made from the pulp. The details of the beating action applied in the paper mill vary greatly over the range of papermaking fibres used, and also over the range of papers' made. More robust fibres may be subjected to a degree of mechanical action that would greatly injure the more delicate. Again, for some types of paper it is necessary, in order to develop certain qualities such as "rattle," resistance to the penetration of water, etc., to subject the pulp to relatively long beating. Since the eucalypt fibre has not so far been used in the papermaking industry, care had to be taken that modifications were made in the heating practice to suit the different qualities of this fibre and to give the best results obtainable. In our opinion, the best method of beating pulp in the laboratory is not by the use of a miniature model of the commercial beater, because with such an apparatus satisfactory control is almost impossible. A method now being widely employed is to beat the sample under examination by rolling it with water and smooth pebbles in a ball mill. At the inception of ball-mill beating experiments on the eucalypts,(the method adopted was based upon the procedure suggested by Wilen, who used a porcelain ball-mill of 4.5 litres capacity charged with 2,500 gms. of flint pebbles weighing 10 gms. each, 25 gms. of pulp and 2,975 ccs. of water, and rotated the mill at 60 revolutions per minute for an hour. The pulp was made into sheets by the use of a sheet machine constructed as follows. A piece of papermachine wire-cloth 8 inches square, of 60 meshes to the inch, supported by heavier wire-cloth, is fitted closely over the top of a brass suction box, the outlet from which is controlled by a valve. A deckle box of brass, hinged so that it can be swung away from the wire, is provided. The pulp suspension is poured into this, and when the valve is opened the water drains away through the wire, leaving the formed sheet; this is removed on a piece of felt by the use of a coucher, pressed, and dried, after which its strength and other qualities may be examined. Wilen's type of sheet-making machine gave very good results and was used throughout the work. The wet sheets, after couching, were supported on either side by blotting paper to control shrinkage, and then laid between felts and pressed six at a time to a fixed point in a letter press. The pressed sheets were then dried between the blotters to about 10 per cent. moisture and finally conditioned at 40 per cent. humidity for a minimum of three hours in a conditioning chamber. The ream weight was then immediately determined, and the Ashcroft

bursting strength test and the Elmendorf tearing test performed.

Beating Apparatus and the Determination of Freeness.

It was, however, soon found that the eucalypt fibres were quickly disintegrated and so gave weak papers. This is understandable when it is considered that Wilen developed his method for the purpose of testing one of the toughest of all paper-making fibres—kraft pulp from spruce.

The nature of the beating action when 10-gram pebbles were used in this ball-mill was first examined by observation of the fibres under a microscope and by the use of the "wetness" or sedimentation tester. The "wetness" of a pulp is the property is acquires, on being beaten, of reducing the rate at which its water drains away. The slower this rate the "wetter" the pulp is said to be, or, in other words, the less "free" it is. The difference between a "free" and a "wet" pulp may be appreciated by taking a portion of a suspension of each in the hand. The free unbeaten pulp will, when squeezed in the hand, part with its water readily, while the wet-beaten pulp under the same treatment will tend to flow between the fingers because of the resistance offered by the pulp to the flow of water through it. For the same reason a wet pulp suspension has a smooth or unctuous feel.

The measurement of the wetness of a pulp after beating is based on the frictional resistance to the flow of water through a collection of fibres, as in a mat of pulp, is a function of this property. The direct determination of this rate is, however, not very simple, and it is usual, in order to simplify the manipulation, to have recourse to the measurement of still more complex functions of the original frictional value required. There are three or more instruments in use for this purpose. It is unfortunate that until recently no attempt had been made by any body representing pulp users to adopt a standardised design of "wetness" or "freeness" tester. The "Canadian Standard Freeness Tester" is such an instrument, but it was not available until the present work was partly finished. The instrument used, the Sedimentation Tester, gives, however, fairly good results, and was used throughout the work in order to obtain directly comparable measurements of the degree of beating of all the pulps dealt with.

When eucalyptus wood pulp was beaten in the ball-mill with 10-gram pebbles, it was found that the wetness, as measured by the Sedimentation Tester, increased very rapidly, but microscopic examination showed that this was caused mostly by an increase in fineness. Five-gram pebbles, however, did not have such a disintegrating effect, and when the wetness, and with it the degree of hydration, had risen sufficiently, the papers made from the pulp were reasonably strong. Further experiments in which the other factors—*e.g.*, ratio of charge of pebbles to charge of pulp, speed of rotation, ratio of total volume of the charge to that of the ball-mill, and density of the pulp suspension—were varied one by one, until, finally, a choice was made of conditions of beating which were rapid, and allowed of the production, at some stage in the beating, of the strongest paper obtainable from the original pulp as determined by its physical and chemical qualities. The quantities and conditions nsed were as follow :— 2,500 gms. of 5 gm. pebbles, a pulp charge of 25 gms. in 1,000 cs. of water, and a speed rotation of the ball-mill of 43 revolutions per minute. Five tests were made, of 30, 60, 90, 120, and 150 minutes' rolliing, the pulp from each lot being made into sheets and tested in order to follow the development of the strength.

Bleaching Tests.

The bleach requirements of a pulp are usually expressed as the parts of standard bleaching powder required to bleach 100 parts of the unbleached pulp. The amount required is found by trial under suitable conditions, and in this work all the pulps were bleached nnder the same condition in order to obtain strictly comparable results. Twenty grammes of pulp was made into a 2.5 per cent. suspension with water and stirred continuously in a glass jar standing in a water bath at 40 deg. C. The consistency of the suspension was such that it was well stirred by a single impeller situated near the bottom of the jar. The "bleach" solution was added in amounts in which tbe standard bleaching powder was in integral percentages of the weight of dry pulp being bleached. By experience of the bleach consumptions of previous pulps, an amount up to 75 per cent. of the actual "bleach" requirement of the pulp could be added at once. Further additions were made as was found necessary, until the colour of the pulp was judged to be white. It is difficult to judge this quantity accurately by the unaided eye, and no optical colour comparimeter was available from which to obtain numerica expression of the colour of the various "whites" dealt with. A method

was, however, adopted which enabled the results of duplicate bleaching tests to agree with each other to within 0.5 per cent. of " bleach " on the pulp; a degree of accuracy which, while not very high, was sufficient for the purpose in view. A pulp that was known to require about 16 per cent. of standard bleaching powder was bleached in four lots of 14, 15, 16 and 17 per cent. standard bleaching powder respectively. The whiteness of the colour of the bleached pulps improved in the series up to the 16 per cent. lot, and was no whiter with 17 per cent. standard bleaching powder. The 16 per cent. lot was taken as a standard with which to compare all the other bleached pulps. The whiteness of this standard was actually quite high, being as good as that of first-grade commercial bleached sulphite pulp.

It was known before these experiments were started, and it was confirmed later, that pulps which will bleach with moderate quantities of bleaching powder, are capable of being bleached to a purer white than those requiring relatively large amounts. It is for this reason that the best " white " obtainable by bleaching a pulp having a consumption as high as 16 per cent. standard bleaching powder was chosen as the standard. Pulps requiring up to 25 per cent. standard bleaching powder to bleach them were found nevertheless to give very nearly the standard white, but on the other hand some pulps were obtained which required only 3.5 to 6 per cent. of bleach, and these, as was expected, were found to be bleachable to a purer white than the standard. The additional bleach consumption required for this was, however, not more than a further 0.5 or 1 per cent. standard bleaching powder, and was in general not determined.

At the final stage of the bleaching in any method, the concentration of the active bleaching substance, the hypochlorite, is lower than at the beginning, and, partly because of this, the rate of bleaching slows down. This is more marked in the method described, since the last part of the bleach is added in smal portions. The practice does not, however, reduce the accuracy of the determination of bleach consumption, for it has been shown by Curran and Baird that the bleach consumption is independent of the concentrhation of pulp during bleaching over a range of from 1 to 7 per cent., and since it follows that at the lowest of these concentrations as much bleaching with dilute, partially exhausted liquor would be done as is done in the method used in this work, the same conclusion is valid.

(To be continued.)

GENERAL NOTES.

TIN IN MANITOBA.

About ten years ago it was found that tin was present in sulphide form in some large bodies of sulphides, consisting mainly of pyrrhotite and pyrite and occurring near West Hawk Lake in south-eastern Manitoba. There are many bodies of pegmatite in the same vicinity, which contain notable quantities of molybdenite, but so far as is known, cassiterite, the oxide of tin, has not been found in them.

Nearly three years ago, cassiterite was found on a small island of rock on Shatford Lake, which lies between Bird (Oiseau) and Winnipeg Rivers. The cassiterite occurs on the margin of a pegmatite dyke, but so near the water's edge that it is not easy to estimate the importance of it. Some interesting samples were brought out shortly after the deposit was located.

Renewed interest was taken in the deposit in the summer of 1928, when it was further investigated. Additional good samples were secured, probably several hundred pounds. The surface work, however, was soon checked, due to the proximity of the lake. The outcrop is now flooded. To investigate the deposit further, it would be necessary to diamond-drill it or to sink a shaft on a neighbouring island to a depth below the lake bottom in the vicinity and then to crosscut to the pegmatite. The recent prominent Press notices were caused by the promise of development by the Manitoba Basin Mining Company.

Cassiterite, no doubt, occurs and there are many pegmatite dykes in the vicinity of the find, many of which carry interesting quantities of lithium minerals. However, prospecting in the vicinity has so far yielded only small traces of tin. The occurrence of cassiterite in commercial quantities has yet to be proved. Moreover, the apparent geographical limitations to tin occurrences, and the general scarcity of tin in Canadian Pre-Cambrian rocks, do not give much promise for economic bodies in Manitoba.

CANADIAN MINERAL PRODUCTION.

Mr. S. H. Logan, General Manager of the Canadian Bank of Commerce, in a review of the Canadian mining industry just issued by the Bank, estimates that the total value of the mineral production of the Dominion in the curren calendar year is likely to reach

$260,000,000, a new high level five per cent. over the previous record figure attained in 1927, and 23 per cent. above the figure of 10 years ago.

Towards this total, precious metals are expected to contribute $52,000,000; the four principal base metals mined in Canada to account for $72,000,000; coal production will aggregate $60,000,000; and other non-metallic minerals $76,000,000. Little change is anticipated from the 1927 totals except in the case of the base metals, which promise an increase of $13,000,000 over the realised total of $59,000,000 reached in 1927 and an approximation to the high level of $74,000,000 attained in 1918, on a very different price level.

PRECIOUS METALS.

The value of the gold production is expected to reach $40,000,000, slightly more than the 1927 figure, decreases from some mining areas being offset by increases in others.

Increased production is likely to arise from more efficient operation of already established producers, and from the development of new ore bodies at lower depths.

Silver production may fall short of the 1927 figure, though the recent gain in price may bring the total value to about $12,000,000, or only slightly less than a year ago, the Oriental markets being the determining factors in prices.

BASE METALS.

There is indicated an output of copper during 1928 amounting to nearly 90,000 tons, valued at about $25,000,000, or 46 per cent. more than in 1927.

The output of nickel over 1928 is expected to reach 44,000 tons, with a value of $18,000,000, as compared with 33,400 tons in 1927, an increase of 31 per cent. for the year and of 400 per cent. over the low-water mark of 1922.

The value of the lead mined in Canada during 1928 is expected to be approximately $18,000,000; and that of zinc, $11,000,000, in both cases nearly four times the value obtained in 1918. The relative values for 1927 were $16,500,000 and $10,200,000.

ASBESTOS AND OTHER NON-METALLIC MINERALS.

The Canadian production of asbestos this year will approximate in value to $11,000,000, an increase of nearly 8 per cent. over last year. In addition to asbestos and coal, there is in sight a production of miscellaneous non-metallic minerals, including clay products, amounting in value to $65,000,000, as compared with a similar figure of $38,000,000 in 1918.

MINING IN NOVA SCOTIA.

The Canadian Official Mining News Letter circulated by the High Commissioner for Canada in London is based on an article by Mr. A. H. A. Robinson, dealing with mining in the Province of Nova Scotia. In that Province, mining has for many years been among the principal industries, the chief product being coal, followed by gypsum and salt. Iron ore, which was mined in Nova Scotia many years ago, has of late years been completely displaced in the local steel industry by ore imported from Newfoundland.

During the past few years there has been a marked revival of interest in Nova Scotia gold mines, and operations are reported on twelve or more of the old abandoned properties many of which are being consolidated with a view to more economic and systematic development.

Developments are also taking place in the production of diatomaceous earth, zinc and lead, copper, tungsten, tin and auriferous antimony, whilst the gypsum and salt mining industries are enjoying great activity.

NEW 80,000H.P. GENERATING STATION IN BRITISH COLUMBIA.

The West Kootenay Power and Light Company, Ltd., a subsidiary of the Consolidated Mining and Smelting Company of Canada, Ltd., intends to develop 80,000 h.p. at the Pend Orielle River in British Columbia at a point near the International Boundary due south of Trail. A minimum expenditure of $4,000,000 is stated to be involved in the undertaking which will rank as one of the largest hydro-electric developments in Western Canada. The Company has already made formal application to the Provincial Government at Victoria for a licence to divert six thousand cubic feet of water per second for the purposes of its scheme.

Continuous expansion at the Trail smelter, and the development of mining and other industries in the interior of the Province, necessitates this great addition to British Columbia's hydro-electric energy. The size of the projected Pend Orielle plant is indicated by comparison with the other plants of the West Kootenay Company. Its largest plant at Bonnington Falls develops 60,000 horse power, while the plant at South Slocan, now about to operate, will have a similar capacity. The Pend Orielle plant will take about two years to complete.

PETROL FROM COAL.

(*From a Fuel Correspondent.*)

Negotiations are now being concluded between American and British groups with the object of producing high-grade motor-spirit from British coal oils by a process which, it is hoped, will ultimately make Britain independent of imported oils and petrol.

Licence to use the process, which has already proved an enormous success in the United States, has been obtained for Great Britain, and a company has been formed for the purpose of erecting plant immediately. Sites are now under consideration.

It is claimed that this important development will not only result in a standardised treatment of coal oils produced in Great Britain—an industry which will be greatly stimulated by the Budget preference of 4d. a gallon or £5 a ton—but it will also give to British motorists a petrol of higher grade than they can now obtain. At the present time 80 per cent. of the petrol used in this country is imported, but the application of this new method to the ever-increasing output of coal oils from low temperature carbonisation will, it is believed, rapidly increase the proportion of home-hade petrol of the highest grade.

An Industrial Romance.

The process in question is known as the Ramage Vapour Phase process, and was invented by a well-known Scotch chemist, Dr. Ramage. Years ago Dr. Ramage offered his process to petroleum interests in this country. It was rejected and he was compelled to take it to the States, where it has since been adopted on a very wide scale.

The rise of gyro petrol, as the spirit produced by the process is called, was almost meteoric. The first company to undertake its manufacture was the McColl Frontenac Refinery Company of Montreal. It was not long before every lorry running in the city was clamouring for the new fuel and to-day the company possesses the largest distributing organisation in Canada. Following this success the process was adopted by the Pure Oil Company, U.S.A., who began with a plant at the Cabin Creek Refinery and during the past five months, in order to satisfy the demand for gyro spirit, have completed three additional plants and are erecting others.

In this country the Ramage Vapour Phase process is in the hands of Lt.-Col. W. A. Bristow, M.I.E.E., M.I.A.E., F.RAe.S., managing director of Low Temperature Carbonisation, Ltd., and Captain W. McKeehnie Robson, who was associated with the formation of the Canadian Company. Briefly it combines the advantages of "cracking" with those of hydrogenation (the addition of hydrogen to increase the heat value). As the petrol can be obtained from any class of charging stock that can be vapourised, the English company will be enabled to manufacture from petroleum oils and coal oils obtained in the cheapest market.

Low Temperature Carbonisation.

Full scale experiments have shown that the process is suitable for treating the crude oil obtained from coal by low emperature carbonisation and it is believed that this is the 'cracking" process which can properly treat this oil.

It is therefore of the utmost significance that negotiotions are now being concluded between American and British groups with the object of setting np a joint technical administration for the purpose of securing from coal oil the maximum percentage of motor-spirit which, of course, will be subject to the Budget preference.

A valuable by-product of the process is a gas of 1850 B.T.U.'s content and it is noteworthy that the Union Carbon and Carbide Company, U.S.A., for the purpose of manufacturing chemical products from the gas, have erected three plants of 500 barrels per day capacity and are erecting three more; while the Shell Company, U.S.A., have taken a licence for 50,000 barrels a day.

LOW GRADE FUEL FOR STEAM STEAM GENERATION.

The Striking Example of a Lancashire Colliery.

The world's coal (and lignite) production remains almost stationary at about 1,400,000,000 tons per annum in spite of rapid increasing demands for heat, light, and power, and included in the reasons for this are the adoption of more and more scientific methods in its use, while also lower grade fuels continue to find an increasing field of application. This latter item is much more important than is generally imagined, especially as regards the economical operation of coal mines, for example, and the use of all the dust and breeze from gas works and coke oven plants. In Great Britain about 7 per cent. of the coal raised, say a consumption of 17,500,000 tons per annum, is required to provide the necessary power, about the average figure throughout the world, and while of course in a large number of cases only non-sale-

able coal is burnt under the boilers at the pit head, this often does not apply, so that the importance of the matter is obvious.

As an example of the savings that are to be obtained, in one very well-known Lancashire Colliery, near Wigan, where unusually careful records are taken, the amount of coal raised is 13,000 tons per week, and under the original conditions 8-9 per cent. of this coal was burnt, corresponding to a value of £660 per week, this having been largely saleable material. The boilers were then equipped with "Turbine" forced draught furnaces, and with the same output the good class coal for steam generation has been replaced by dust, smalls and belt pickings, all with a high ash content. As a result, calculated on the amount of coal made available for sale, the total coal bill at this colliery—although still 8.7 per cent. of the coal raised as regards weight of fuel—is now only £340 per week, instead of the previous figure of £660, that is a saving of 48.5 per cent., or no less than £320 per week.

The point is that scientific methods in the industrial boiler plant enable low grade refuse and non-saleable material to be burnt without difficulty, and as already indicated, in many collieries the quality of the coal used under the boilers is unnecessarily good. Also apart from this the average thermal efficiency of the consumption of the coal is too low, irrespective of the quality, the saving possible on any boiler plant being generally made up of two parts, thermal efficiency or proper use of the coal, and the nett cost of the fuel, that is the price paid per actual heat unit, this latter being particularly important for chemical and industrial establishments in general.

CANADIAN CHEMICAL NOTES.

Mineral Resources of the Peace River District.

The Natural Resources Intelligence Branch of the Dominion Department of the Interior at Ottawa has just issued a new edition of its handbook on "The Peace River Country—Its Resources and Opportunities," by F. H. Kitto, F.R.G.S. The booklet in question contains a section dealing with the mineral resources in the Peace River conntry, including references to placer gold discoveries, gold-bearing quartz deposits and discoveries of silver-bearing galena.

Up to the present time, however, no metallic deposits of note have been identified in the Peace River country east of the Rocky Mountains, but extensive areas are underlain with various non-metallic minerals, the principal being coal, natural gas, brine, gypsum and possibly petroleum.

In the matter of coal, it is believed that in the Peace River district there is one of the most important coal fields of western Canada, both as regards area and quality. A National Coal Reserve of about 550 square miles has been set aside in the Smoky River coal district.

Copies of the handbook may be obtained by persons interested on application either to the Department of the Interior at Ottawa or to the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

Low Temperature Carbonisation Plant for Ontario.

The Montreal Gazette states that a plant for the low temperature carbonisation of Nova Scotia coal is shortly to be erected at Prescott, Ontario, on the River St. Lawrence. Plans have heen designed for the constrnction of a plant capable of handling 300 tons daily, producing a solid, smokeless fuel which should be a strong competitor of imported anthracite. Bituminous coal is to be brought up the St. Lawrence by steamer throughout the season of navigation and in sufficient quantity to enable the plant to continue operations throughout the winter months.

Lithium from South Eastern Manitoba.

Report No. 687 of the Mines Branch of the Dominion Department of Mines, dealing with "Investigations on Mineral Resources and the Mining Industry, 1926," contains, inter alia, an article by Mr. H. S. Spence in regard to "Lithium Minerals in South Eastern Manitoba," where a discovery of an important deposit was reported in 1924.

The deposit in question is now under development by an English Company and was the first indication of the existence in Canada of lithium minerals of economic importance. Since 1924, prospecting has been stimulated and lithium minerals have been reported from a number of localities in the Province, these including Cat Lake, Bernic Lake and West Hawk Lake, all in the south eastern portion of the Province.

The Report in question may be consulted at the Canadian Building, Trafalgar Square, London, S.W.1., and copies can be obtained

from the Mines Branch of the Dominion Department of Mines at Ottawa.

LARGE IRON OCHRE DEPOSIT IN SASKATCHEWAN.

According to the *Regina Leader*, deposits of iron ochre roughly estimated at 50,000 tons have been discovered near Makwai Lake, north of St. Walburg on the Turtleford Branch of the Canadian National Railways.

Mr. W. H. Hastings, the Provincial mining engineer, is stated to have made an inspection of the deposits and to have reported the mineral to be very uniform in texture and colour.

THE APOTHECARIES HALL.

The ravages of the death-watch beetle in the fine old Hall of the Society of Apothecaries have been found to be more extensive than was first thought when the damage was discovered some time ago.

Several oaken beams, which were apparently sound, are found to be infested with the insect, and are being replaced by steel girders.

The cost of the repairs will be very large. The present Hall dates from a few years later than the Great Fire of London, which destroyed the original Hall founded by Gidean de Laune, Apothecary to James I.

In the Court Room are some fine old paintings, including a portrait of James I., who granted the Society's Charter in 1617.

Proceedings and Notices of Societies

ROYAL INSTITUTION.

The Before Easter Lectures at the Royal Institution will commence on Tuesday, January 15, at 5.15 p.m., when Dr. F. A. Freeth begins a course of two lectures on "Critical Phenomena in Saturated Solutions." On Tuesday, January 29, Professor J. S. Huxley delivers the first of six lectures on "Evolution and the Problem of Species." On the following Tuesdays there will be two lectures by Dr. S. W. Kemp, on "Antarctic Whaling Investigations." On Thursdays there are to be two lectures by Major Gordon Home on "Roman London"; three by Sir William Bragg on "The Early History of X-Rays"; two by Professor A. O. Rankine on "Physics in Relation to Oil Finding"; and three by the Rev. W. H. Draper, the Master of the Temple, on (1) "The Use of Language, and its Difficulties"; (2) The Handling and Interpretation of Metaphor"; (3) "Change in the Meaning of Words from one Period to Another." On Saturdays afternoons at 3 p.m., there will be three lectures by Dr. Emile Cammaerts, on "Flemish and Belgian Art"; three lectures with musical illustrations on "Music in Cathedral and Collegiate Churches," by Dr. Stanley Marchant and Dr. Ernest Bullock; and four by Sir Ernest Rutherford on "Molecular Motions in Rarefied Gases."

The Friday Evening Meetings will commence on January 18, when Sir William Bragg will deliver a discourse on "Further Progress in Crystal Analysis." Succeding discourses will probably be delivered by Professor A. C. Seward, Professor J. L. Myres, Mr. C. E. R. Sherrington, Dr. E. K. Rideal, Dr. F. A. Bather, Sir Robert Robertson, Professor T. F. Tout, Professor V. M. Goldschmidt and Sir Ernest Rutherford.

ROYAL SOCIETY OF ARTS.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, Captain Sir Arthur Clarke, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m., on Thursday, January 3, and Thursday, January 10. The lectures will be fully illustrated by lantern slides. The syllabus of the lecture is as follows :—

Lecture I.—The Story of the Ship.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides wil show the development of the merchant ship and the batteship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

Lecture II.—Lighthouses.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult.

IMPERIAL COLLEGE OF SCIENCE, LONDON.

ANNIVERSARY DINNER.

On December 10, Lord Buckmaster presided over the annual dinner of the above, which was held at the Hotel Victoria, London.

Sir John Gilbert, Chairman of the Education Committee of the L.C.C., proposed "The Imperial College." He said this was the 21st anniversary of the granting of the charter to the College. It was an unique institution in an unique University, and it was very difficult to assess the great value of its research work. After dwelling on the services it had rendered to the Allied forces during the Great War, he said that a feature of the College was its extraordinary connection with all the great Dominions of the Empire. The University of London was rightly described as an Imperial University, and the most imperial of the colleges associated with it was undoubtedly the College of Science and technology. It would not be an exaggeration to describe the Imperial College to-day as a kind of Mecca for students of all British Dominions overseas who wished to take a course of advanced work or research work in connection with any branch of science or technology. (Cheers.)

Lord Buckmaster, responding, said there were no fewer than 250 persons in the college engaged in the work of research. If all were known that was owed by this country to the work of the Imperial College in the past, they would no longer have to go cap in hand to benevolent institutions and rich men and ask for the money essential to carry on that work.

Lord Morris, president of the Imperial College Association, proposed the toast of "The Guests."

Sir H. Frank Heath and Sir William Pope, Prime Warden of the Goldsmiths' Company, responded.

SOCIETY OF GLASS TECHNOLOGY.

The Society of Glass Technology met in Stourbridge on Tuesday and Wednesday, November 20 and 21, 1928. On the evening of November 20 the President, Mr. Walter Butterworth, Senior, M.A., lectured on "Byzantine, Saracenic and Venetian Glass."

In the production of artistic glass, he said, the outstanding periods were the Egyptian, Roman, Byzantine and Saracenic, Venetian, German, French, and the Modern, in which English flint glass occupied a worthy place. Probably the Venetian was the most brilliant of all these, and the Byzantine and Saracenic period preceded it. Venice held pride of place in the production of artistic glass for several centuries. She drew much knowledge from Egypt, Rome, Constantinople, and Damascus.

The Byzantine Empire, 330-1453, founded by Constantine with its capital Constantinople, had a troubled and chequered history. Constantine encouraged arts and industry, attracted skilled artists and workers, including glass-makers who became numerous, occupying the quarter near the "Gateway of Glass." Their glassware soon commanded exports to Alexandria, Persia, etc.

Enamel painting on glass was apparently begun by Greeks under Byzantine rule.

In the seventh century the Arabs conquered Syria, Egypt, and Spain in the eighth century, and oriental influences spread westwards. Saracen glass coins and weights were in use, some being stamped with the names of Caliphs from 720 to 1225. The glass factories at Damascus became famous, and this fame lasted until the fourteenth century.

In the fifteenth century the manufacture of beautiful glass passed to Venice. Glass-making had been carried on much earlier in Venice, and so great was the extent of the manufacture of mosaics and beads, that in 1292 the Grand Couucil ordered the removal of all glass works to Murano. The Guild of Glass Blowers was already formed, and processions were organised to display the fine glasses made. The city regarded the indnstry as "the apple of her eye," and repressive laws were passed to keep it within her power. Drastic measures were taken to prevent emigration of workers, and workshop regulations were stringent. Four categories of glass were made (1) canes for beads, (2) canes for pearls and enamels, (3) hollow ware and general, (4) window and plate glass. Each section had its guild, and the State kept a "Libro d'Oro," skilled workers being regarded as a class of nobility.

Following the suggestion of Marco Polo, the great Venetian traveller, a considerable export trade was obtained.

During the first half of the sixteenth century Venetian glass reached its zenith for incomparable craftsmanship, grace, lightness, and delicacy of form, it was a triumph of blown glass of a thin, delicate type tending towards the fantastic. The variety of the graceful glasses was astonishing, and a great trade was done with Europe, Asia, and the far East.

The tendency to let the playful fancy of the craftsman run riot was, in time, to undermine the fine qualities of Venetian glass. In the effects of filigrane, millefiori, and *lattecinio*, the ability of the Venetians seemed to have no limit. Show pieces of the exquisite work were exhibited in guild processions, etc., and the fame of this work influenced the course of glass manufacture in other countries.

After the sixteenth century foreign competition from France, Bohemia, Germany, the Netherlands, and England, dealt a severe blow to Venice whose craftsmen had at last carried away her secrets. In the seventeenth century English cut lead flint glass became the rage ousting Venetian and Bohemian styles. The florid style of Venetian glass remained in favour for some time, and usually specimens of this period are found in museums. Political circumstances contributed towards the decline of the Murans' craft in the eighteenth century, and in 1806 the number of glass works had sunk to twelve.

At the present a vigorous trade had again arisen, but it was only a shadow of the former grandeur.

On Wednesday, November 21, the meeting was devoted to "Glassworks Refractory Materials." The discussion was initiated by Prof. W. E. S. Turner, who spoke on "Recent Progress in the Study of Refractory Materials." He referred at the outset to the work of the Refractories Committee of the Society of Glass Technology, and to the general report (drawn up by Mr. W. J. Rees, (the Chairman of the Committee) which had recently been published. Prof. Turner went on to state some of the most important problems awaiting solution; and referred at some length to work which had been done by the German Society of Glass Technology.

The results of the two independent sets of inevstigation showed a good deal of concordance. Particulars were given of a number of British and German clays of various compositions and types. Clays rich in alumina were more resistant to the action of a lead batch than were clays with a lower alumina but a higher silica content. Similar results were obtained with soda-lime-silica, and with opal glass batches. Clays with high ferric oxide content were less resistant to corrosion than those with low ferric oxide avlues. Sodium sulphate was the one raw material to which highly silicious clays were more resistant than the highly aluminous clays. Emphasis was laid upon the greater importance of porosity on the properties and behaviour of the glass. Clays with high porosity were most susceptible to attack. High temperature firing of refractory materials for the glasshouse was most important. Clays with high alumina content were better for nearly all purposes than were clays of low alumina content, provided the clays were given adequate firing.

Professor Turner also referred to investigations on the tensile strength and expansion of his glass house refractories by Mr. J. F. Hyslop and his colleagues at the Research Laboratories of the General Electric Company Limited, at Wembly.

Mr. J. F. Hyslop supplemented Professor Turner's remarks and gave some details of his experiments. He pointed out that the composition of the material was important. With light or moderate burning it was possible that siliceous refractory materials might give superior results to aluminous materials. All the indications, however, were that the best possible results were only obtainable by using materials of high alumina, or mullite content which has been adequately fired.

The following reports were also communicated :—

A Summary of Faults and Defects which may Arise in the Manufacture and Use of Glasshouse Pots. Their Cause and Prevention. By PERCIVAL MARSON.

The Durability of Glasshouse Pots. By J. F. HYSLOP, B.Sc.

Memorandum on the Purification of Clay, Heat-Treatment of Pots and the Use of Sillimanite Pots. By PROFESSOR W. E. S. TURNER.

INSTITUTION OF CIVIL ENGINEERS.

NEW MEMBERS.

At the meeting on December 4, the following were elected Members :—

Associate Members.—Adamson, J. L.; Alecock, C. E. K.; Allcock, G. T.; Atkins, W. S. A.; Bard, L. P.; Barrett, H. C.; Barrow, F. L.; Bateman, R. W.; Beeson, W. G.; Benjamin, J. A.; Berry, C. V.; Biglin, J. E.; Billing, J. M.; Blair, L.; Blumfield, C. V.; Blythe, P. W.; Budgen, H. P.; Burns, T. F.; Cattigan, J. W.; Cave, G. B. H.; Cocks, E. B.; Cotterill, H. S.; Cowan, T. O.; Crooks, R.; Dallas, D. A.; Danks, J. Y.; Davies, B. W.; Davies, F. H.; Davis, A. T.; Dean, A.; Dean, P. T.; Dodman, G. B.; Donald, J. A.; Duckworth, H.; Dunn, H. C. E.; Dunthorne, A. C.; Duvivier, J.; Fitzpatrick, R. T.; Fortune, R. E.; Foster, H.; George, H. H.;

Glover, C. R.; Glyde, H. S.; Goode, J. E.; Goodman, R. T. W.; Goodridge, J. H.; Gray, C. S.; Greenhough, F. H.; Greig, L. C.; Haldane, H. R.; Hales, C. H.; Hardern, S. C.; Holdsworth, D.; Holt, J.; Hope C. K.; Hoyte, E.; Jaggar, N. L.; Jardine, A. H.; Kelting, E. L.; Kirkpatrick, R. H.; Kitching, J.; Lee, J. McC.; Leebody, J. W.; Lang, J. W. B.; Lutter, G. H. F.; MacLaren, A. S.; MacNiven, J.; MacPherson, J.; Medcalf, S. H.; Meegama, Don Wilfred E.; Miller, G. B.; Miller, J.; Mirams, R. A.; Mobberley, E. A.; Morris, J. C.; Mulgrew, J.; Munro, W. A.; Naldrett, A. G.; Nichols, J. A.; Niven, T. M.; Oldfield, J.; Paterson, A. B.; Patterson, R. H. S.; Peace, R.; Pegg, R. N.; Perry, A. H.; Porter, R. B.; Power, G. W.; Richards, T. G.; Rock, L. G. B.; Russell, J.; Samuel, D. S.; Sandifer, D. A. N.; Sellier, C. J.; Shannon, W. B.; Shaw, W. A.; Southall, H.; Spencer, C. W.; Squires, S. G.; Sullivan, J. A.; Suthems, B. W.; Symington, A. A.; Taylor, J.; Thorold, W. G. P.; Trace, R. V.; Trapp, C. S.; Tregurtha, F. C. P.; Turner, F. E.; Tweedale, N.; Vaux, H. O.; Verity, C. E. H.; Walker, J. H.; Weldon, L. F.; Westbrook, R. P.; Wignall, W. B.; Wikeley, J. B.; Wilson, E. R.; Wolf, W. A. L.; Woodger, C. E.; Young, D. F.; Young, J. Zylva, P. A. de.

Associate.—Wheeler, R. P.

Transferred from Associate Members to Members.—Batham, W. S.; Braine, C. D. H.; Brown, R. D.; Hedley, R.; Henderson, W.; Holt, P.; John, T. G.; Knight, A. O.; Robinson, W. P.; Stradling, R. E.

The admission of 239 students is also reported.

NINETEENTH ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY.

The Nineteenth Annual Exhibition of the Physical and Optical Societies is to be held on Tuesday, Wednesday, and Thursday, January 8, 9 and 10, 1929, at the Imperial College of Science, Imperial Institute Road, South Kensington, and will be open in the afternoon from 3 p.m. to 6 p.m., and in the evening from 7 p.m. to 10 p.m.

Over eighty firms have accepted the invitation to exhibit in the Trade Section at this exhibition, and in addition a group of research and experimental exhibits is being arranged, which will be shown by Fellows of the Societies and others, and a number of research laboratories and other institutions. Some interesting historical exhibits will also be included.

The discourses, which will be given at 8 p.m. on each evening, are as follows:—

On anuary 9.—Professor F. Lloyd Hopwood, M.A., F.Inst.P.: "Experiments with High Frequency Sound Waves."

On January 9.—Mr. Conrad Beck, C.B.E.: "Lenses."

On January 10.—Mr. A. J. Bull, M.Sc., F.Inst.P.: "Some Colour Problems in Photo-Engraving."

We understand that invitations to the Exhibition have been sent to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Royal Aeronautical Society, the Royal Meteorological Society, the Faraday Society, and a number of other societies and bodies. As in previous years members of these societies should apply for tickets to their secretaries. Others may obtain tickets on application to the Secretary, the Physical and Optical Societies, 1, Lowther Gardens, Exhibition Road, London, S.W.7. Tickets are required only on January 8 and 9. Admission on the third day, January 10, will be without ticket.

Forthcoming Events.

ROYAL SOCIETY OF ARTS.

ARRANGEMENTS FOR MEETINGS DURING JANUARY, 1929.

Wednesday, January 16, at 8 p.m.—(Ordinary Meeting). Professor Charles R. Darling, A.R.Sc.I., F.I.C.: "The Domestic Smoke Problem—A Practical Solution."

Monday, January 21, at 8 p.m.—(Cantor Lecture.) C. H. Lander, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research: "The Treatment of Coal." (Lecture I.)

Wednesday, January 23, at 8 p.m.—(Ordinary Meeting). Sir Henry A. Miers, F.R.S.: "Museums and Education." The Right Hon. the Earl of Crawford and Balcarres, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

Monday, January 28, at 8 p.m.—(Cantor Lecture). C. H. Lander, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research: "The Treatment of Coal." (Lecture II.)

Wednesday, January 30, at 8 p.m.—(Ordinary Meeting.) George Fletcher: "The Shannon Scheme and Its Economic Consequences."

NOTICES OF BOOKS.

Untersuchungen uber Enzyme. By PROF. R. WILLSTATTER. Pp. 1,200. Berlin: Julius *Springer.* 1928. *Price* 124 marks.

This comprehensive treatise which must have occupied Prof. Willstatter and his fifty eminent collaborators many months of arduous compiation, covers as completely as possible the whole subject associated with enzymes and their behaviour. The work deals with general analytical and preparative methods, hydrogels, adsorbents, chlorophyllase and plant lipases, peroxidase and katalase, saccharase (invertin); maltase, lactase and fermentation generally; emulsion; pancreas enzymes, plant proteases and includes the results of Prof. Willstatter's exhaustive researches on chlorophyll and other plant products. These comprehensive volumes thus constitute a convenient collection of this important work in biochemistry.

CORRESPONDENCE.

THE BRITISH STEEL INDUSTRY.

SAFEGUARDING CONDEMNED.

To the Editor of THE CHEMICAL NEWS.

Sir,—Mr. R. Storry-Deans, M.P., speaking in London on 4th inst., said that if 2,500,000 tons of the steel at present imported were made in Britain, this would give employment to 100,000 extra workers, and would also mean the consumption of 8,000,000 more tons of coal.

If these figures are correct, they explain why Britain is not competitive. Both figures are a long way higher than either the Continental or American practice.

Let me make a little calculation. The bulk of the 2,500,000 tons at present imported consists of steel billets, strips, bars, joists and plates, the average price of which does not exceed £7 per ton delivered here, making a total of £17,500,000.

Mr. Deans says if this steel were main in Britain the labour cost would be 100,000 men at £156 each, making a total of £15,600,000—that is nearly £6 per ton for wages only, leaving £1 per ton to cover cost of raw materials, oncost and overhead charges!

When it is remembered that it only requires 1,250,000 tons of pig-iron (plus scrap) to produce the 2,500,000 tons of steel, the figure of 8,000,000 tons of coal is abnormally high.

If this is the case for Safeguarding, then it has completely broken down.

These alarming figures have been confirmed by the Steel Makers themselves in a printed leaflet issued recently on their behalf by the Empire Industries Association, London. They have also been confirmed by the President of the Board of Trade. If it costs £6 for labour and requires about 4 tons of coal to produce one ton of steel then that is all the more reason why British consumers must have Free Trade.

Britain has an export iron and steel trade at present of over four million tons per annum. To retain this large export business *she must have access to cheap sources of* supply of the necessary raw and semi-raw materials.

I am, etc.,

DAVID MACMILLAN.

Glasgow.

11 December, 1928.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

35,918.—Dyson, G. M.—Manufacture of ammonium salt. December 5th.

35,576.—I. G. Farbenindustrie Akt.-Ges. —Apparatus for manufacture of sulphates. December 3rd.

35,577.—I. G. Farbenindustrie Akt.-Ges. —Production of acetaldehyde from acetylene. December 3rd.

36,047.—I. G. Farbenindustrie Akt.-Ges. Manufacture of complex metallic salts. December 5th.

35,579.—I. G. Farbenindustrie Akt.-Ges. —*Purifying crude* benzol, etc.

Specifications Published.

301,402.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.) — Manufacture and production of unsaturated aliphatic hydro-carbons.

275,273.—Gulker, F.—Method of producing hydrogen.

301,523.—Imperial Chemical Industries, Ltd., and Horsley, G. F.—Production of esters.

301,645.—Cooke, F.—Manufacture of coal tar.

283,105.—I. G. Farbenindustrie Akt.-Ges. Manufacture and production of hydro-carbons poor in hydrogen.

Abstract Published.

298,778.—Silicic acid esters. — Johnson, J. Y., 47, Lincoln's Inn Fields, London. — (I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany).

The manufacture of silicic acid esters by the interaction of silicon tetrachloride and alcohols is performed in the presence of inert diluents, whereby the necessity for dehydrating the alcohols is avoided. The examples describe the interaction o fsilicon tetrachloride with ethyl and methyl alcohols in the presence of benzene, and the working up of the products.

The Latest TRADE MARKS

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TERPOFLOR.

495,693.—Chemical substances prepared for use in medicine and pharmacy.—Albert Landrin, 135, Boulevard Haussmann, Paris, France. December 12th.

LENIFORME.

496,796.—Chemical substances prepared for use in medicine and pharmacy.—Albert Landrin, 135, Boulevard Haussmann, Paris, France. December 12th.

OSPRA.

494,794.—Chemical substances prepared for use in medicine and pharmacy, but not including medicinal oils, and not including any goods of a like kind to medicinal oils. — Aspro, Ltd., Buckingham Avenue, Trading Estate, Slough, Buckinghamshire. December 12th.

ERGORONE.

496,656.—Chemical substances prepared for use in medicine and pharmacy.—Société Des Usines Chimiques Rhone-Poulenc, 21, Rue Jean-Goujon, Paris, 8e, France. December 12th.

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